

Daily report 12-04-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

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Situation report 29

Contact: clara.prats@upc.edu

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Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of tendencies**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 5-7 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ α : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ K : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

Next, we show a report with 8 graphs and a table with the short-term predictions for (1) European Union and its countries, (2) other countries, (3) Spain and its autonomous communities.

We are currently adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold:

- ✓ Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more → 3-5 days prediction;
- ✓ Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days → 2 days prediction;
- ✓ Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days → 1 day prediction.

We have introduced a change in fittings, that are now weighted at some points. The whole methodology employed in the inform is explained in the last pages of this document.

Martí Català, MD
Pere-Joan Cardona, PhD
*Comparative Medicine and Bioimage Centre of
Catalonia; Institute for Health Science Research
Germans Trias i Pujol*

Clara Prats, PhD
Sergio Alonso, PhD
Enric Álvarez, PhD
Daniel López, PhD
*Computational Biology and Complex Systems;
Universitat Politècnica de Catalunya - BarcelonaTech*

With the collaboration of: Guillem Álvarez, Oriol Bertomeu, Laura Dot, Lavínia Hriscu, Helena Kirchner, Miquel Marchena, Daniel Molinuevo, Pablo Palacios, Sergi Pradas, David Rovira, Xavier Simó, Tomás Urdiales

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(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs

In EU+EFTA+UK countries as a whole, the control is still not consolidated. **Total deaths exceed 70,000 and the ρ is above 1**, again. Extra effort should be made in order to stop the expansion.

The four countries with the highest attack rate, Spain (344 per 10^5 inhabitants), Italy (252), Germany (144) and France (144), represent about half of the new daily cases of EU + EFTA + UK. Nevertheless, **UK (116) is the country with the highest daily new cases in Europe, around 6,500, and with an increasing trend given by a ρ of 1.4**. UK is moving fast to the 4th position of countries with highest incidence, with about 10,000 cumulated deaths.

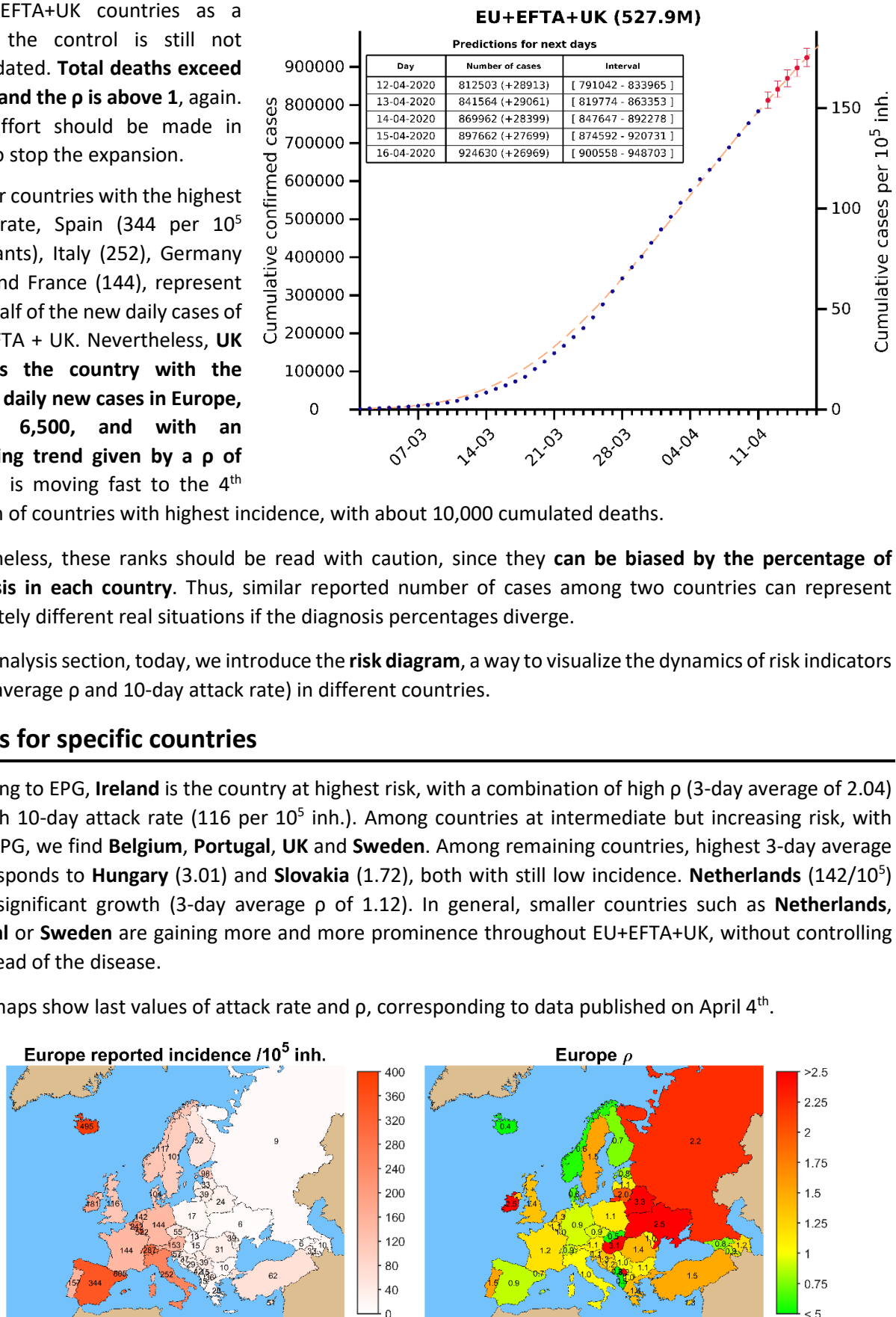
Nevertheless, these ranks should be read with caution, since they **can be biased by the percentage of diagnosis in each country**. Thus, similar reported number of cases among two countries can represent completely different real situations if the diagnosis percentages diverge.

In the Analysis section, today, we introduce the **risk diagram**, a way to visualize the dynamics of risk indicators (3-day average ρ and 10-day attack rate) in different countries.

Trends for specific countries

According to EPG, **Ireland** is the country at highest risk, with a combination of high ρ (3-day average of 2.04) and high 10-day attack rate (116 per 10^5 inh.). Among countries at intermediate but increasing risk, with $EPG2 > EPG$, we find **Belgium, Portugal, UK and Sweden**. Among remaining countries, highest 3-day average ρ corresponds to **Hungary (3.01)** and **Slovakia (1.72)**, both with still low incidence. **Netherlands (142/ 10^5)** shows significant growth (3-day average ρ of 1.12). In general, smaller countries such as **Netherlands, Portugal or Sweden** are gaining more and more prominence throughout EU+EFTA+UK, without controlling the spread of the disease.

These maps show last values of attack rate and ρ , corresponding to data published on April 4th.



Situation and trends per country

Table of current situation in EU countries, according to data published by ECDC on April 12th. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables.

Country	Reported data						Indexes		
	Cumulated cases	Attack rate / 10 ⁵ inh.	Cumulated deaths	Mortality /10 ⁵ inh.	Active cases (last 10 days)	Active cases (last 10 days) /10 ⁵ inh.	Mean $\rho^{(1)}$	EPG ⁽²⁾	EPG2 ⁽²⁾
Spain	161,852	349.2	16,353	35.3	59,716	128.8	0.82	105.2	86.0
Italy	152,271	256.2	19,470	32.8	41,697	70.2	0.89	62.5	55.7
Germany	120,479	147.1	2,673	3.3	46,957	57.3	0.87	50.0	43.7
France	93,790	144.9	13,832	21.4	36,801	56.9	1.10	62.5	68.6
United Kingdom	78,991	118.9	9,875	14.9	49,517	74.5	1.17	87.2	102.0
Belgium	28,018	246.7	3,346	29.5	14,054	123.7	1.03	128.0	132.5
Switzerland	24,820	289.6	831	9.7	7,750	90.4	0.75	67.6	50.5
Netherlands	24,413	143.7	2,643	15.6	10,799	63.6	1.12	71.0	79.4
Portugal	15,987	154.1	470	4.5	7,736	74.6	1.29	96.3	124.3
Austria	13,807	158.5	337	3.9	3,096	35.5	1.02	36.3	37.1
Sweden	10,151	103.2	887	9.0	5,204	52.9	1.43	75.6	108.1
Ireland	8,928	188.9	320	6.8	5,481	116.0	2.04	236.5	482.3
Poland	6,356	16.6	208	0.5	3,802	9.9	1.05	10.5	11.0
Norway	6,320	117.7	98	1.8	1,655	30.8	0.53	16.3	8.6
Denmark	5,996	105.0	260	4.6	2,889	50.6	0.80	40.2	32.0
Romania	5,990	30.3	282	1.4	3,530	17.8	1.11	19.8	22.0
Czech Republic	5,902	55.6	129	1.2	2,313	21.8	0.92	20.1	18.5
Luxembourg	3,270	567.7	62	10.8	951	165.1	0.83	136.7	113.1
Finland	2,905	52.8	49	0.9	1,459	26.5	0.95	25.2	24.0
Greece	2,081	18.6	93	0.8	706	6.3	0.96	6.0	5.8
Iceland	1,689	463.7	8	2.2	469	128.8	0.45	57.4	25.6
Croatia	1,534	36.4	21	0.5	571	13.6	1.24	16.8	20.8
Hungary	1,410	14.5	99	1.0	825	8.5	3.01	25.5	76.9
Estonia	1,304	99.4	24	1.8	525	40.0	0.56	22.4	12.5
Slovenia	1,188	57.2	50	2.4	347	16.7	0.97	16.3	15.8
Lithuania	1,053	36.2	23	0.8	472	16.2	1.09	17.8	19.4
Slovakia	728	13.4	2	0.0	328	6.0	1.72	10.4	17.9
Bulgaria	661	9.3	28	0.4	239	3.4	0.92	3.1	2.9
Latvia	630	32.0	3	0.2	184	9.3	0.89	8.3	7.5
Cyprus	616	52.6	15	1.3	296	25.3	1.12	28.3	31.7
Malta	370	86.2	3	0.7	182	42.4	ND	ND	ND
Liechtenstein	80	207.5	1	2.6	8	20.7	ND	ND	ND

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	200.0	200.0
Best	Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

⁽¹⁾ Disclaimer: parameter ρ is very sensitive and experiments daily variations. Mean ρ is averaged per 3 consecutive days, but it can still vary the following days.

⁽²⁾ EPG stands for Effective Growth Potential. It is obtained by multiplying attack rate per 10⁵ inhabitants of last 10 days (i.e. density of cases) by ρ (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG2 is a similar index but attack rate of last 10 days is multiplied by ρ^2 .

Highlights for countries with highest number of reported cases

- ✓ Among the 5 countries with more cases, UK is the one with highest expected new cases, in the range of 7,000-8,000 daily and with an increasing trend. Spain, Italy, Germany and France could be in a similar range of 3,000-4,000 new cases daily, but different trends (decreasing for Spain, Germany and France, and stable for Italy).
- ✓ Spreading rates of these countries are near the growth-control threshold, in the range of 0.8-0.9 in the case of Spain, Italy and Germany and between 1.1 and 1.2 for France and UK (3-day average ρ).

Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per 10^5 inhabitants (only for countries that have overtaken this threshold). Data from 12th April (source: ECDC).

Countries	Days since the first 50 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
'Italy'	50	11	16
'France'	44	10	20
'Germany'	44	12	17
'Spain'	43	7	12
'United_Kingdom'	40	11	19
'Norway'	39	9	24
'Switzerland'	39	9	12
'Netherlands'	38	11	20
'Sweden'	38	10	ND
'Austria'	37	10	14
'Belgium'	37	11	14
'Greece'	36	18	ND
'Iceland'	36	5	15
'Denmark'	34	4	30
'Czech_Republic'	33	11	ND
'Finland'	32	12	ND
'Portugal'	32	9	15
'Slovenia'	32	6	ND
'Ireland'	31	8	18
'Romania'	31	15	ND
'Estonia'	30	5	ND
'Poland'	30	17	ND
'Bulgaria'	28	ND	ND
'Luxembourg'	28	6	7
'Slovakia'	28	24	ND
'Croatia'	27	12	ND
'Latvia'	26	12	ND
'Cyprus'	25	12	ND
'Hungary'	25	20	ND
'Malta'	24	8	ND
'Lithuania'	23	9	ND
'Liechtenstein'	18	9	11

Analysis: Risk diagrams

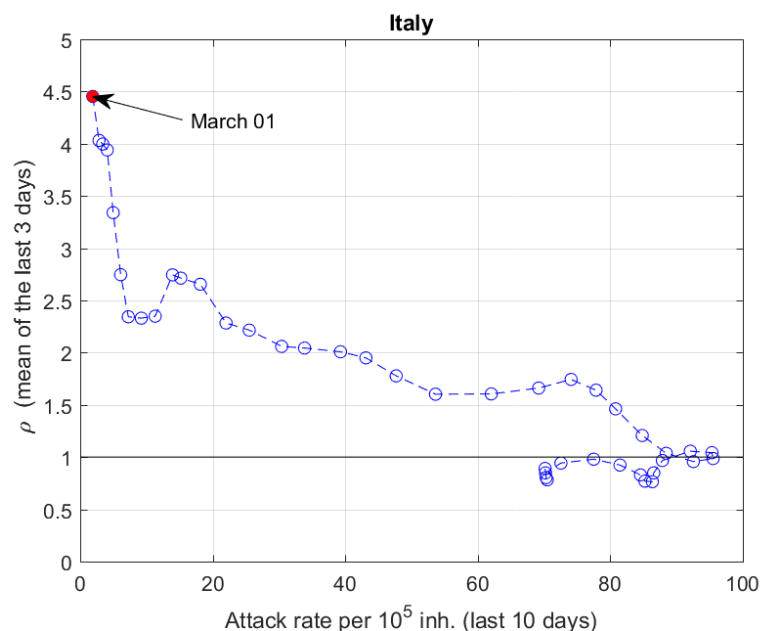
Variable ρ assesses the **rate at which epidemic is spreading**. It could be expected that its value decreases as soon as control measures are taken, but reality shows that its decrease is slow. In fact, even in a situation of strict confinement, contagions may continue for long periods due to unavoidable contact inside families, residences and health centres, among others.

The risk of secondary outbreaks is also determined by the **pool of infectious individuals**. A possible estimation of these active cases is the **reported attack rate of last 10 days by 10^5 inhabitants**. Indeed, this variable is not the real infectious subpopulation, which is almost impossible to determine. Infectiousness of an individual varies within infection's cycle and also depends on his/her age, social activity and severity of the illness, among others. Nevertheless, the dynamics of such estimation of active cases is a good indicator of the risk's dynamics associated to active cases. In addition, the use of an intensive magnitude (given by 10^5 inh.) permits the comparison among different regions.

The proposed **risk diagram** shows the **evolution of this pair of variables associated to risk along the infectious period**. Parameter ρ is shown as the average of 3 consecutive days to reduce the associated noise due to daily data. In fact, **the product between 3-day average ρ and 10-day attack rate is given in tables as Effective Potential Growth (EPG)**, and allows for a quantitative assessment of the risk. Next, we show the risk diagram for different countries and discuss the observed dynamics.

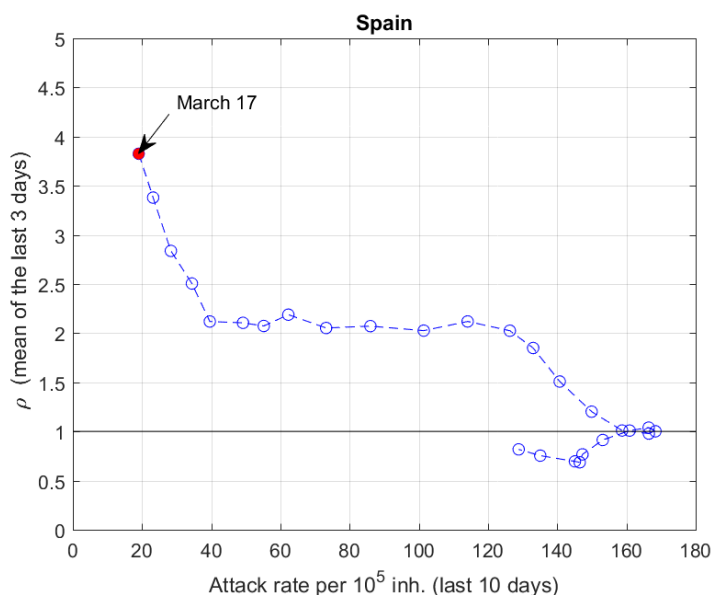
Italy

We observe that on 1st March the 10-day attack rate was low, but spreading rate was very high. Spreading rate decreased rapidly for a few days, but stabilized between 2 and 1.5 for around 10 days. This resistance to effective decrease once confinement measures are implemented is probably due to endogenous contagions inside closed nuclei such as families and residences with at least one infected, where the disease keeps spreading. Then, attack rate keeps increasing for a long period which, at the same time, prevents a decrease in ρ . Once these endogenous contagions reach saturation, ρ starts decreasing again and reaches the control zone ($\rho < 1$). At this point, 10-day attack rate starts decreasing as well, observing a backwards shift in the plot. While 10-day attack rate is still high, the risk for secondary outbreaks to be triggered is kept high, since the reservoir of infectious people that can potentially spread the virus is considerable. In this situation, an increase in ρ up to a level greater than 1 can be dramatic because of this infectious potential.



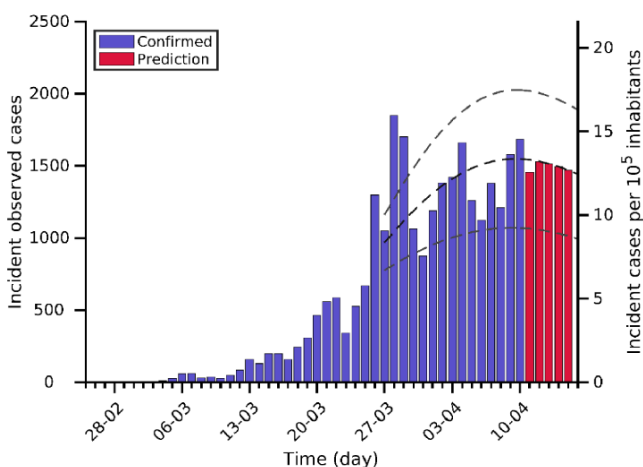
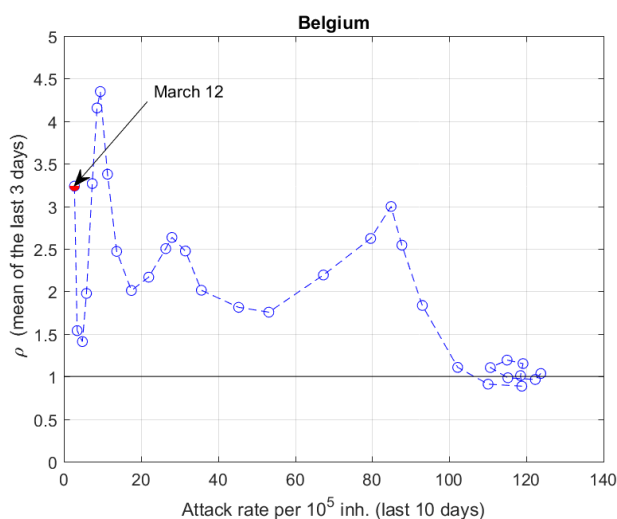
Spain

The observed dynamics of Spain and Italy are similar because both countries have followed a similar epidemic cycle. Nevertheless, 10-day attack rate is significantly higher. Therefore, the effects of partial deconfinement measures proposed by tomorrow (13th April) must be closely followed, because the risk of secondary outbreaks is still high. A daily tracking of mobility and confinement indexes can be useful to this end.



Belgium

In Belgium we observe a couple of cycles of short control's period followed by a short growth's period. This is observed as a backwards shift followed by a forward shift in 10-day attack rate (left). This is confirmed by the observed oscillations in new cases bar diagram (right). These oscillations can be associated with new outbreaks at the regional scale. In any case, the plot shows (and EPG confirms) that risk is still high in this country, although they are fluctuating around $\rho \approx 1$.



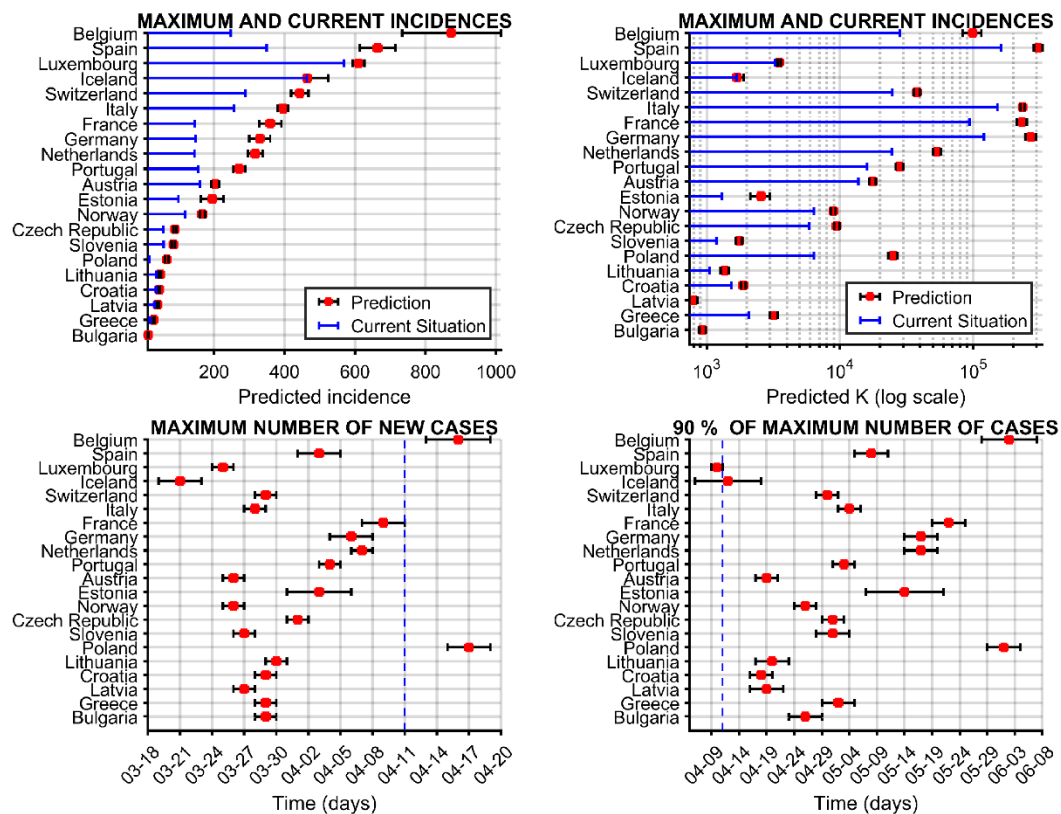
Conclusions

The proposed risk diagram graphically shows the evolution of the risk situation of a country or a region. The distance of ρ above or below 1 together with the magnitude of 10-day attack rate are useful for assessing risk evolution in time. It permits the clear observation of new increases in incidence after a control period. **At the end of this Dashboard we show risk diagrams of all UE+EFTA-UK countries.** Note that “y” axes (ρ) are plotted in the same scale, but “x” axes (10-day attack rate) are particularly adapted to the range of each country.

Long-term predictions

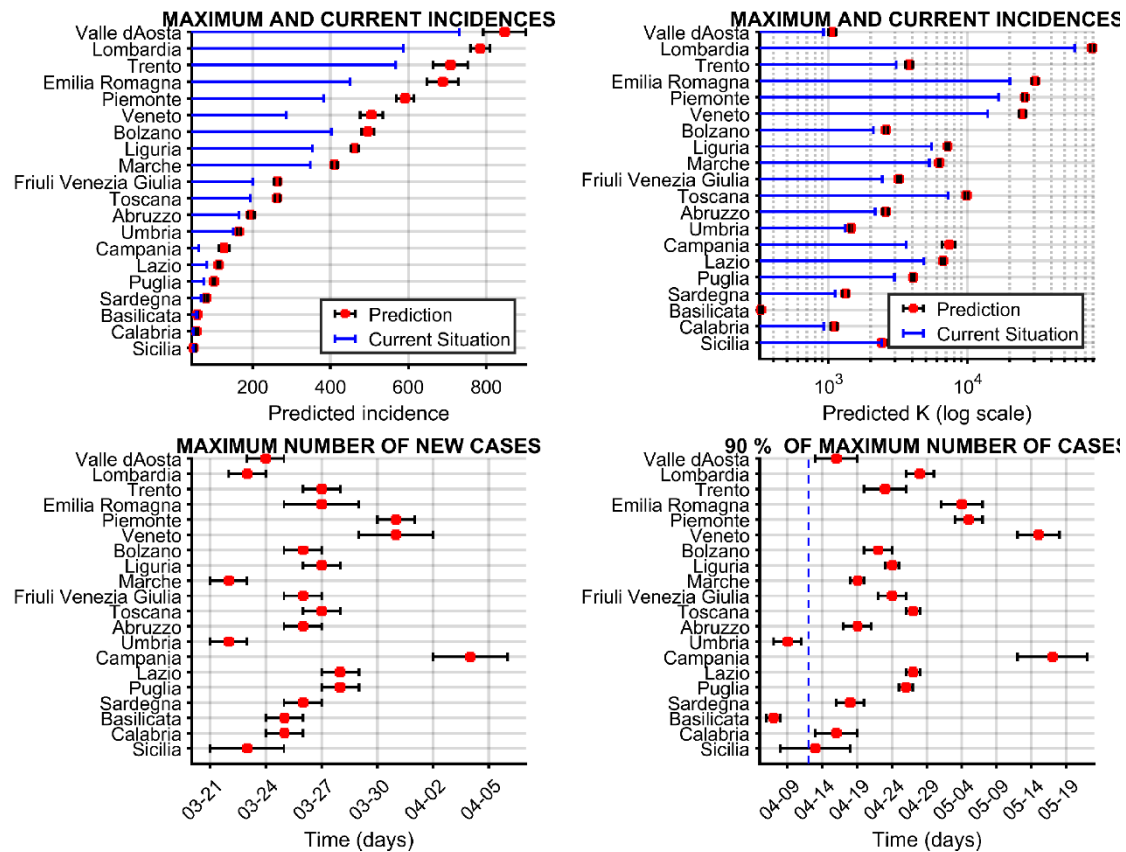
These plots show long-term predictions of: new cases' peaks, final incidence value and approximate date when 90% of total final incidence will be reached. In all three cases we are dealing with the evaluation of global dynamics, which requires small changes in methodology: all data points be used instead of last 15 and with equal weight distribution among them. Blue dashed line indicates current timepoint. See details in Report from 11th April 2020.

UE-EFTA-UK countries (data from 11/04/2020)

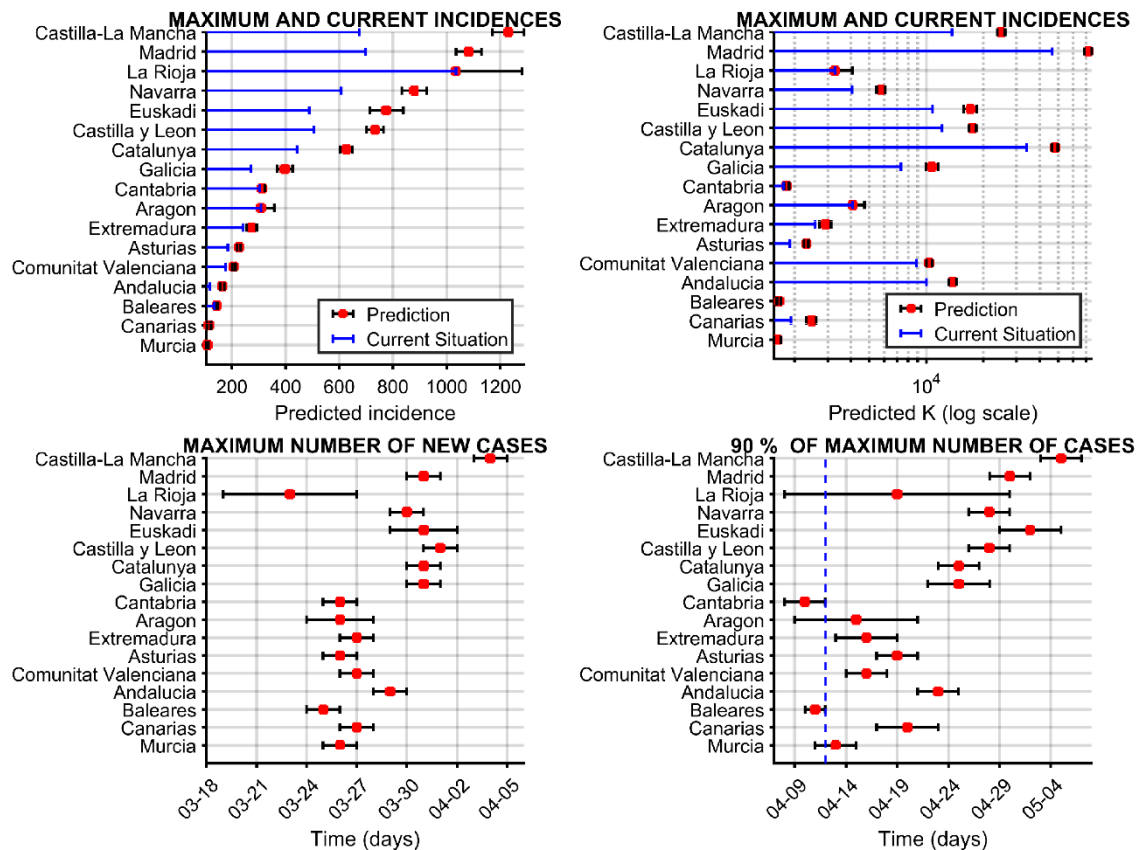


In the next page, we show same plots for Italian and Spanish regions. Then, the dynamics of Spanish regions predictions with time are shown, so that their convergence (or not) can be checked.

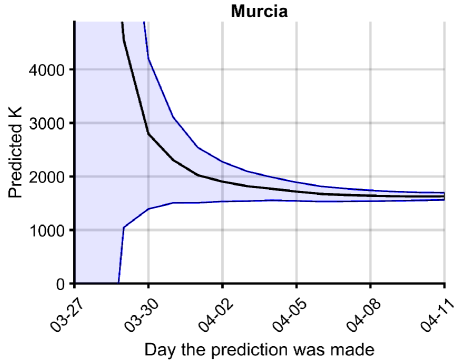
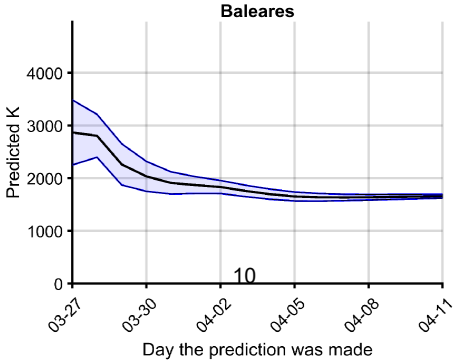
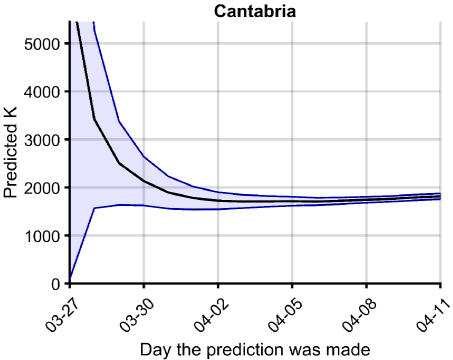
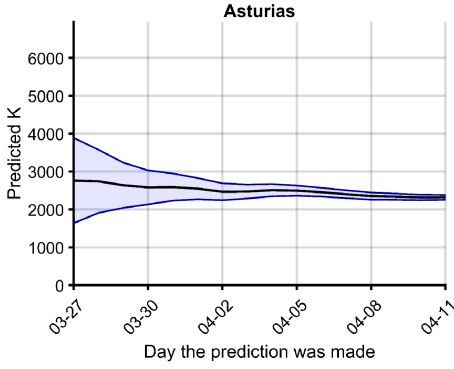
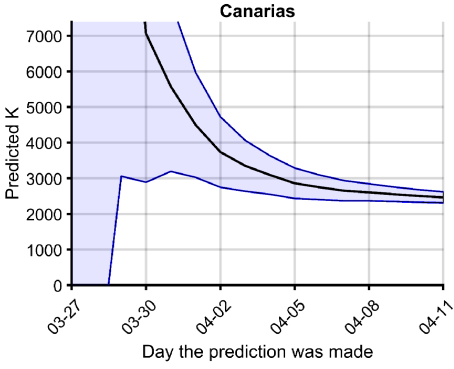
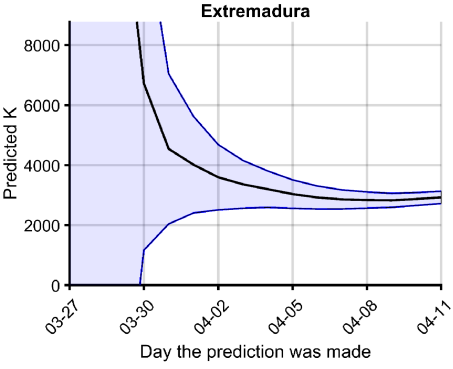
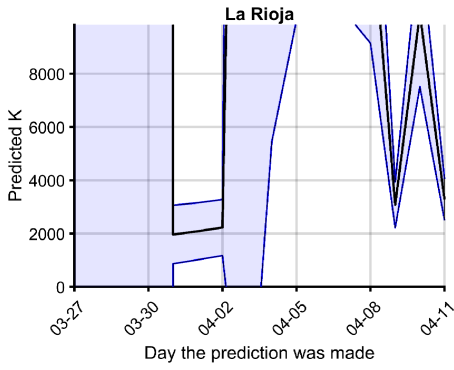
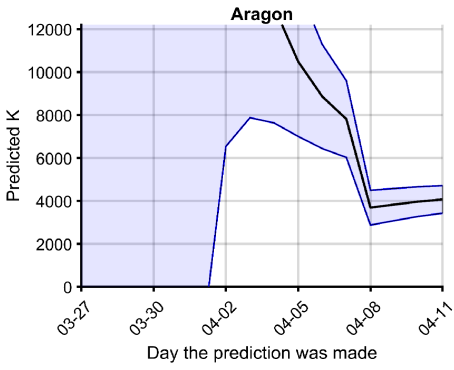
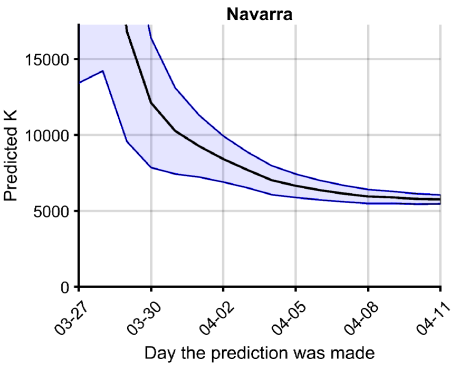
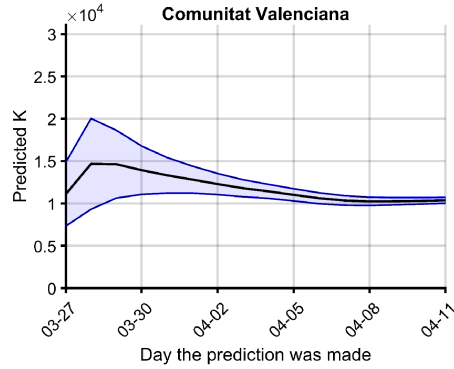
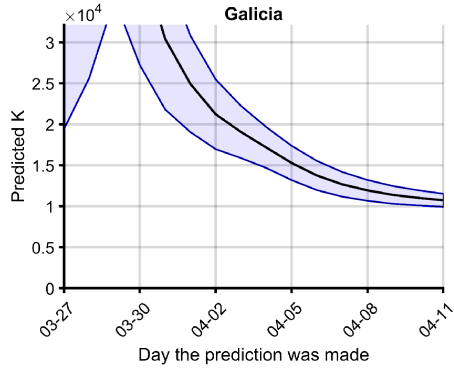
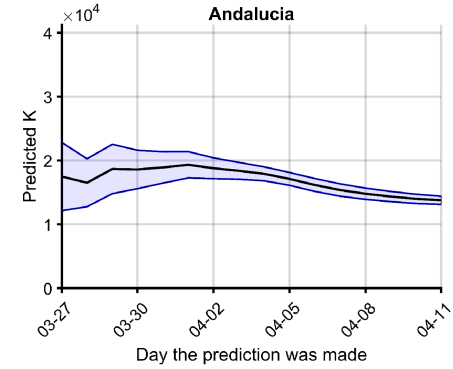
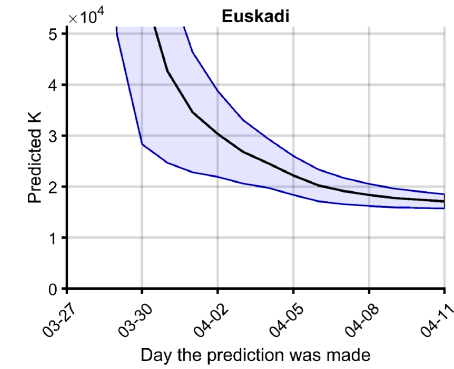
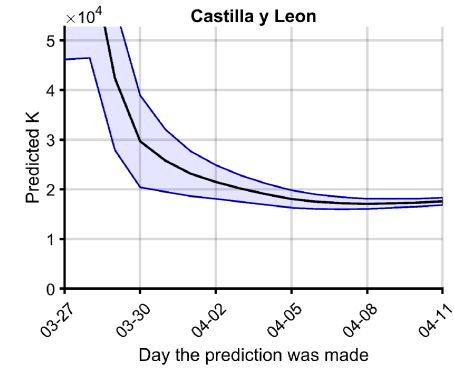
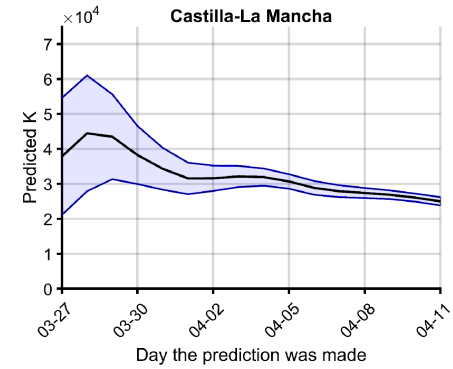
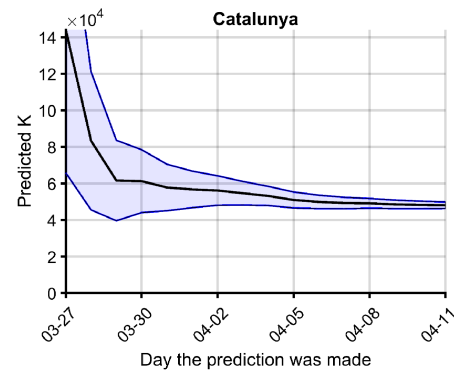
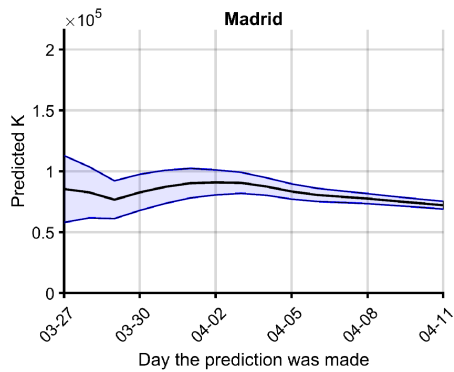
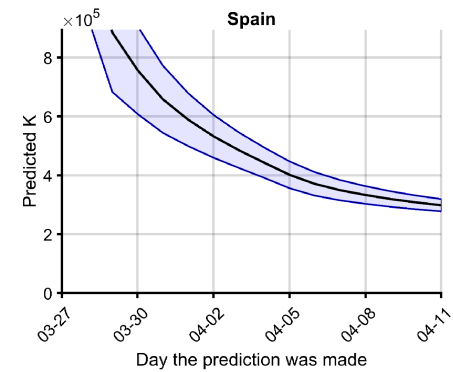
Italian regions (data from 12/04/2020)



Spanish regions (data from 12/04/2020)



2020-04-12



Situation and tendencies in Italian and Spanish regions

Italy. Data from 12/04/2020

Country	Reported data						Indexes		
	Cumulated cases	Attack rate / 10 ⁵ inh.	Cumulated deaths	Mortality / 10 ⁵ inh.	Active cases (last ten days)	Active cases (last ten days) / 10 ⁵ inh.	Mean $\rho^{(1)}$	EPG ⁽²⁾	EPG2 ⁽²⁾
Lombardia	59,052	588.1	10,621	105.8	12,987	129.3	1.07	138.6	148.5
Emilia Romagna	20,098	450.7	2,564	57.5	4,765	106.9	0.90	96.5	87.2
Piemonte	16,660	382.4	1,729	39.7	6,307	144.8	1.06	153.8	163.4
Veneto	14,077	286.9	856	17.4	3,966	80.8	1.20	96.7	115.7
Toscana	7,235	194.0	495	13.3	1,962	52.6	1.16	61.0	70.7
Liguria	5,494	354.3	749	48.3	1,712	110.4	0.77	85.1	65.5
Marche	5,303	347.7	700	45.9	1,205	79.0	0.96	75.9	72.9
Lazio	4,845	82.4	279	4.7	1,412	24.0	1.03	24.8	25.5
Campania	3,604	62.1	242	4.2	1,148	19.8	0.68	13.5	9.2
Trento	3,053	284.7	293	27.3	1,050	97.9	1.36	133.6	182.3
Puglia	2,989	74.2	260	6.5	912	22.6	1.09	24.6	26.7
Friuli Venezia Giulia	2,431	200.0	195	16.0	632	52.0	0.79	40.9	32.2
Sicilia	2,416	48.3	163	3.3	625	12.5	1.07	13.4	14.4
Abruzzo	2,160	164.7	212	16.2	663	50.5	1.34	68.0	91.4
Bolzano	2,098	1,952.8	205	190.8	619	576.2	0.84	482.4	403.8
Umbria	1,319	149.5	52	5.9	191	21.7	0.34	7.3	2.5
Sardegna	1,113	67.9	73	4.5	319	19.5	1.25	24.4	30.5
Calabria	923	47.4	66	3.4	232	11.9	0.62	7.4	4.5
Valle d'Aosta	921	733.2	112	89.2	253	201.4	0.53	107.4	57.3
Basilicata	315	56.0	18	3.2	69	12.3	0.52	6.3	3.3
Molise	257	84.1	15	4.9	92	30.1	0.67	20.2	13.6

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2	500.0	500.0
Best	Best	Best	Best	Best	Best	Best	0	0.0	0.0

Spain. Data from 12/04/2020

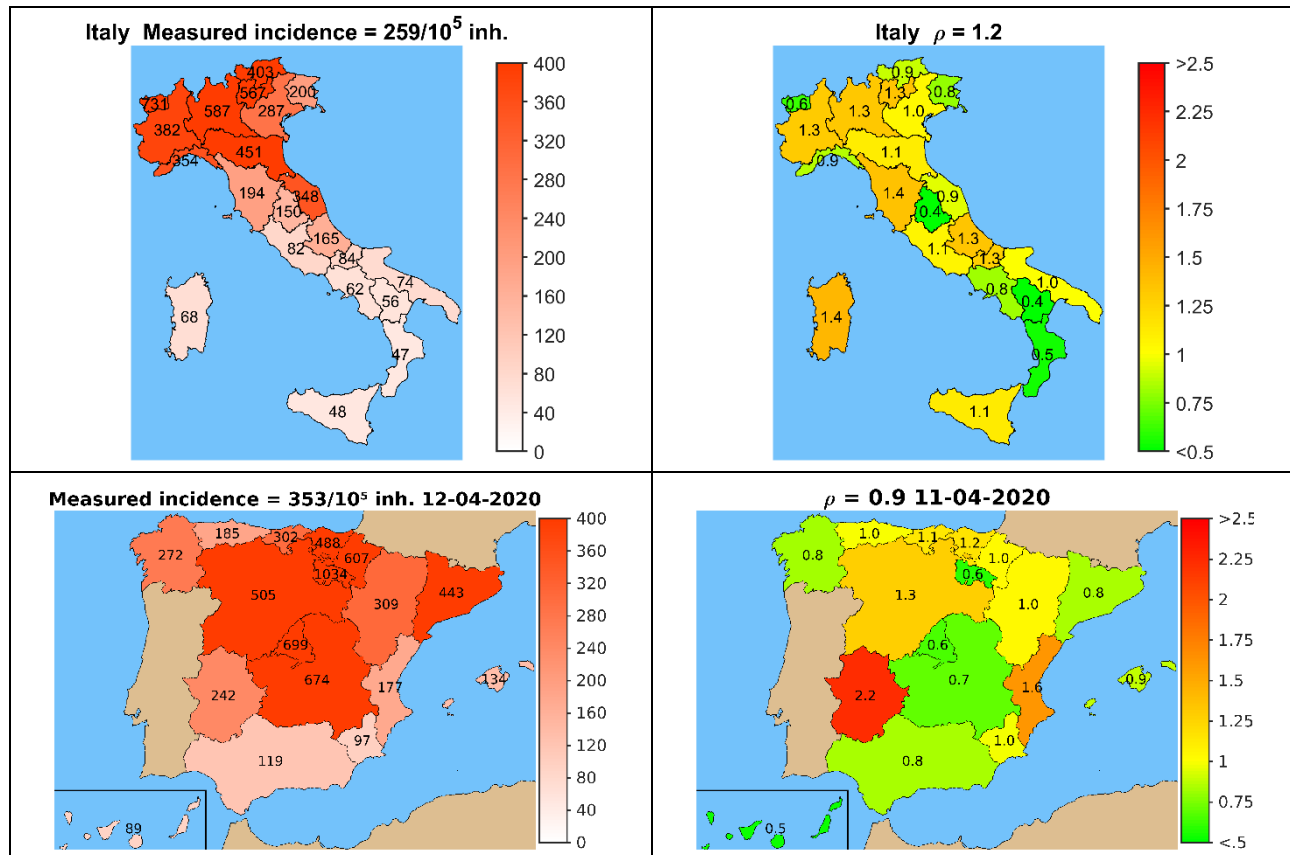
Autonomous regions	Reported data						Indexes		
	Total cumulated cases	Attack rate /10 ⁵ inh.	Cumulated deaths	Mortality rate /10 ⁵ inh.	Active cases (last 10 days)	Active cases (last 10 days) /10 ⁵ inh.	Mean $\rho^{(1)}$	EPG ⁽²⁾	EPG2 ⁽²⁾
Madrid	46,587	701.5	6,278	94.5	14,432	217.3	0.73	158.4	115.4
Catalunya	34,027	449.8	3,442	45.5	12,223	161.6	0.88	142.8	126.2
Castilla-La Mancha	13,698	673.0	1,543	75.8	6,016	295.6	0.78	230.3	179.4
Castilla y Leon	12,118	503.2	1,221	50.7	4,763	197.8	1.19	235.3	279.9
Euskadi	10,772	494.6	804	36.9	3,455	158.6	1.02	162.1	165.6
Andalucia	10,006	118.7	799	9.5	3,034	36.0	0.66	23.8	15.7
Comunitat Valenciana	8,841	177.7	838	16.8	2,533	50.9	1.31	66.7	87.5
Galicia	7,336	271.7	274	10.1	2,494	92.4	0.69	63.5	43.6
Aragon	4,070	308.1	450	34.1	1,370	103.7	0.89	92.4	82.3
Navarra	3,969	610.6	232	35.7	1,287	198.0	0.97	192.7	187.6
La Rioja	3,279	1,045.7	219	69.8	1,196	381.4	0.5	200.2	105.1
Extremadura	2,580	242.2	312	29.3	743	69.7	1.67	116.1	193.4
Canarias	1,918	86.9	95	4.3	474	21.5	0.7	14.7	10.1
Asturias	1,892	185.1	140	13.7	508	49.7	0.70	34.8	24.4
Cantabria	1,752	301.2	110	18.9	484	83.2	0.99	82.0	80.9
Baleares	1,534	129.1	112	9.4	330	27.8	1.24	34.5	42.8
Murcia	1,449	97.4	97	6.5	365	24.5	0.80	19.7	15.8
Melilla	98	115.7	2	2.4	36	42.5	ND	ND	ND
Ceuta	93	109.6	4	4.7	38	44.8	ND	ND	ND

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	500.0	500.0
Best	Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

⁽¹⁾ Disclaimer: parameter ρ is very sensitive and experiments daily variations. Mean ρ is averaged per 3 consecutive days, but it can still vary the following days. ⁽²⁾ EPG stands for Effective Growth Potential. It is obtained by multiplying attack rate per 10⁵ inhabitants of last 10 days (i.e. density of cases) by ρ (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG2 is a similar index but attack rate of last 10 days is multiplied by ρ^2 .

Maps of Italian and Spanish regions

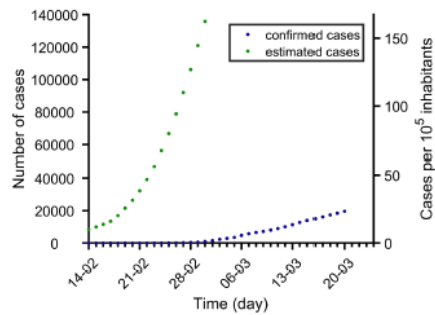
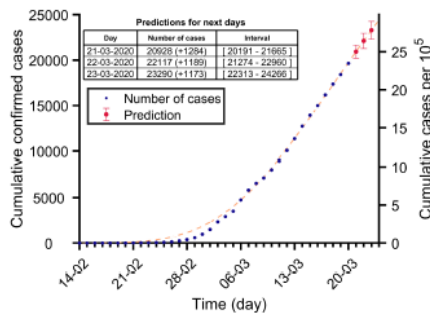
Cumulated incidence and spreading rate (ρ) in Europe, Italian regions and Spanish autonomous communities.
Data from 12/04/2020.



Legend: Countries' reports details

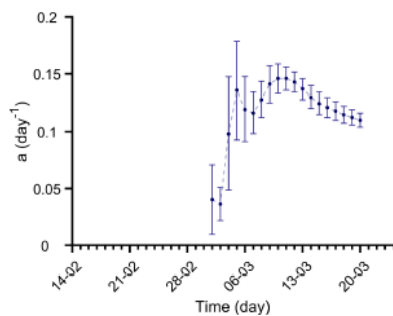
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: $23/10^5$

Confirmed cases:
data (blue),
model fitted
(dashed line),
predictions (red
points and table)

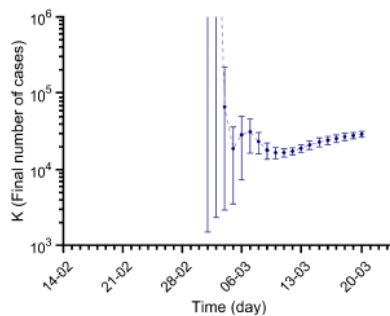


Estimated
cases using
death rate (see
Methods)

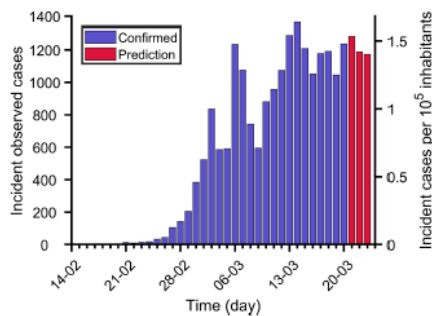
Fitted a value
using points
prior to each
date



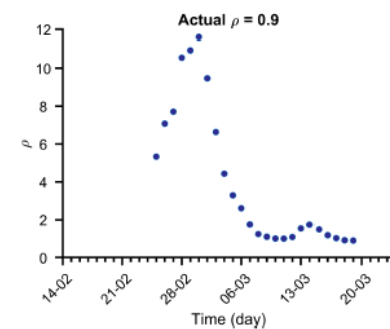
Fitted K value
using points
prior to each
date



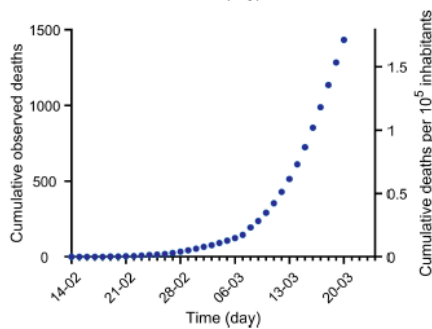
Reported
and
predicted
new cases



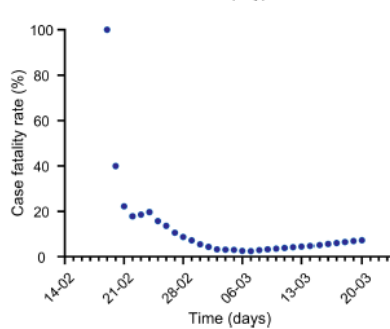
Evolution of ρ , a
parameter related
with Reproduction
number (see
Methods)



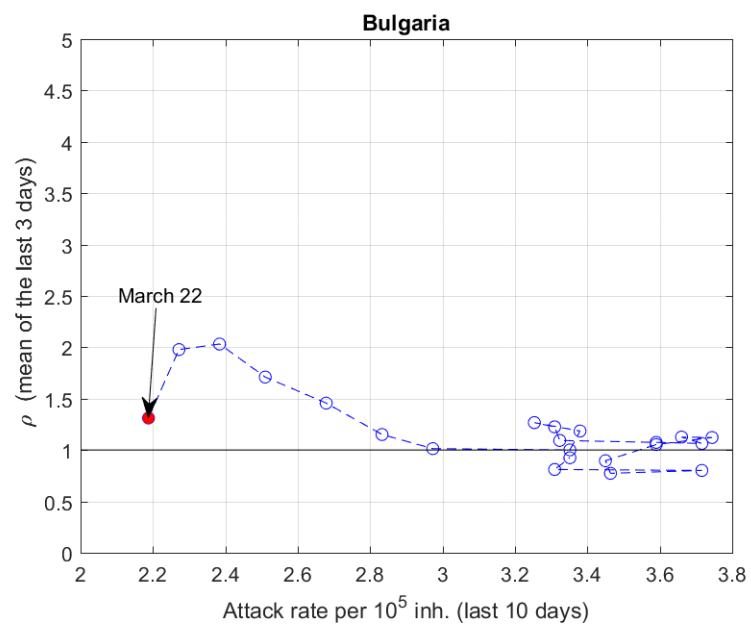
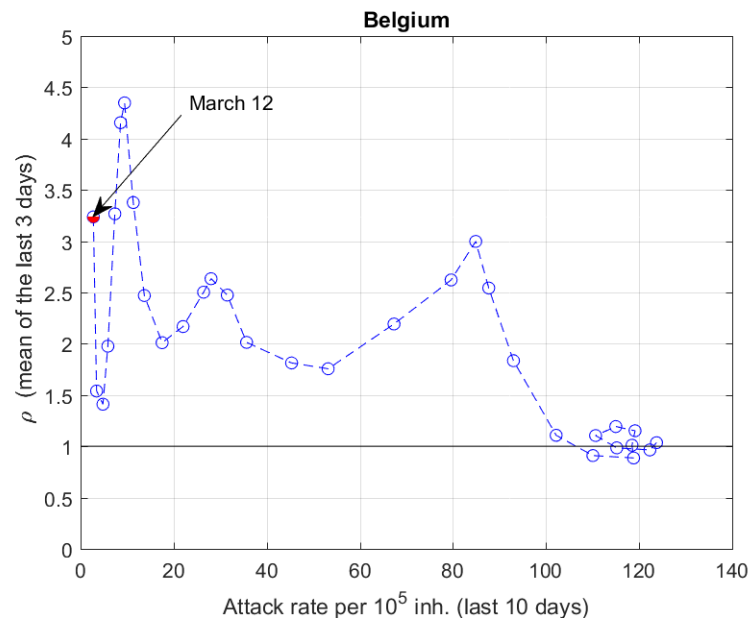
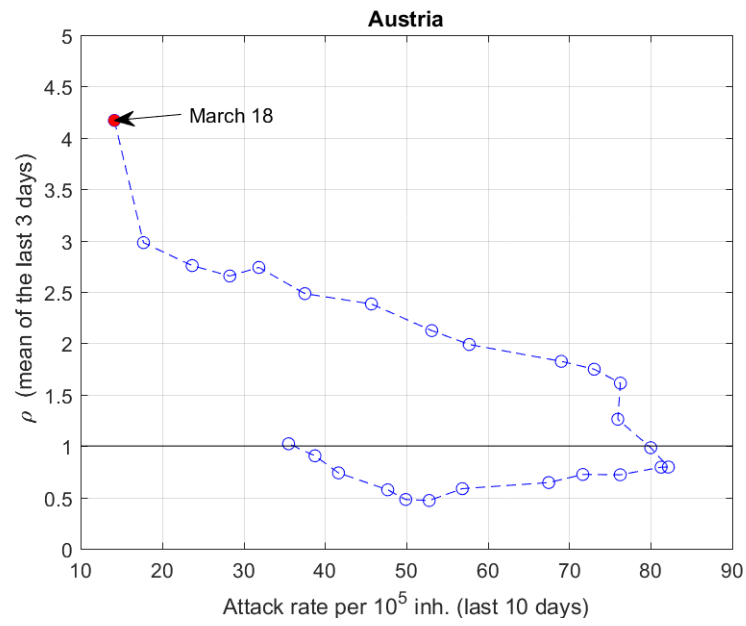
Reported
deaths

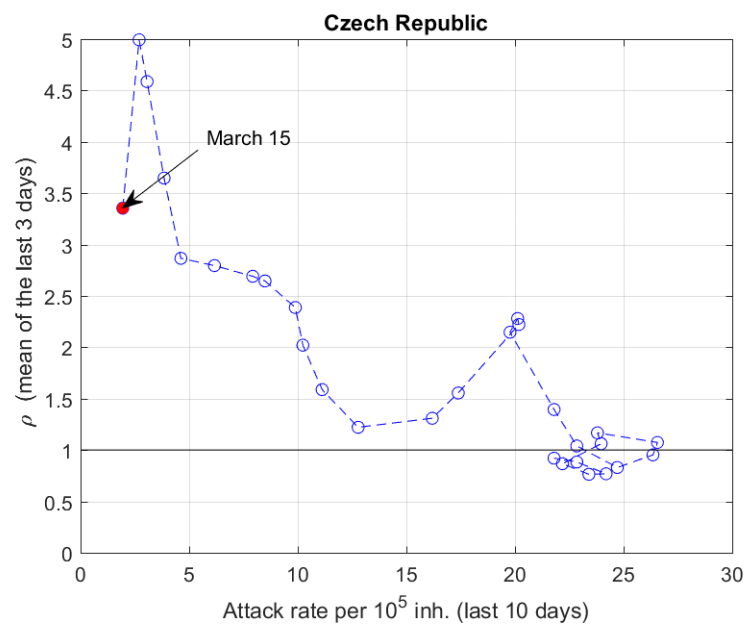
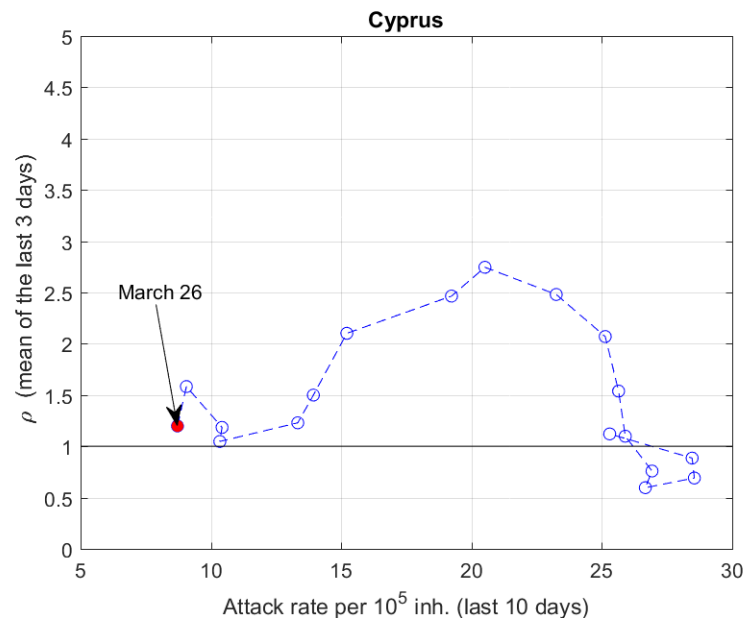
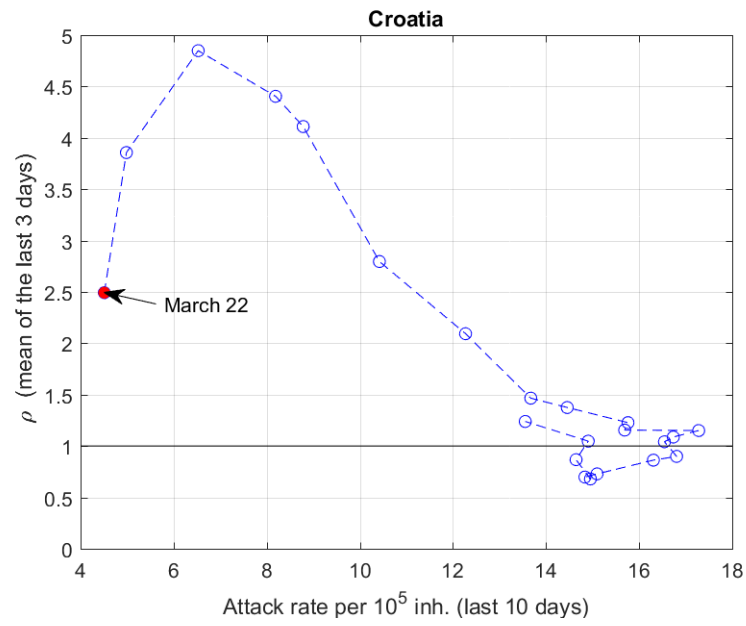


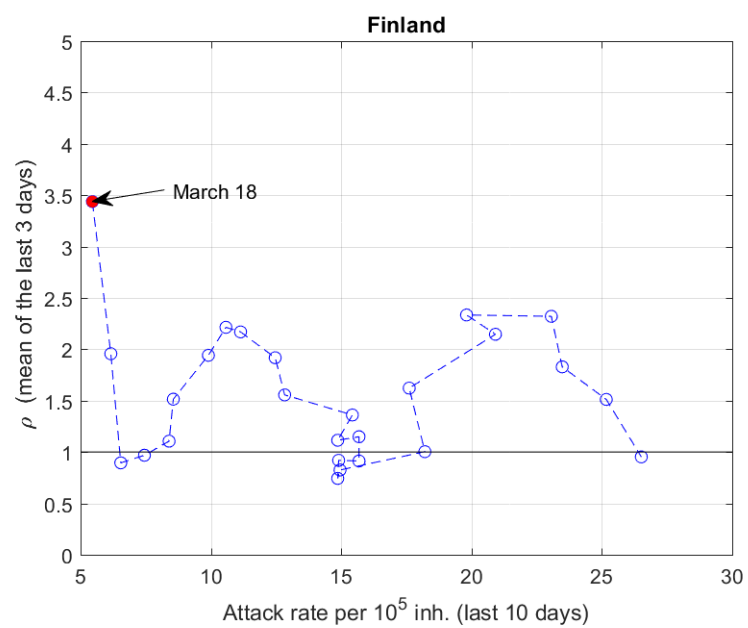
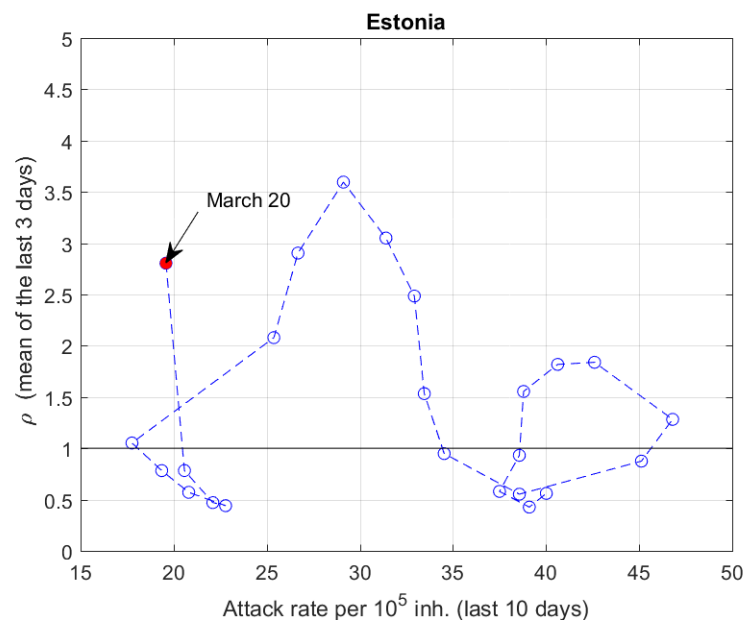
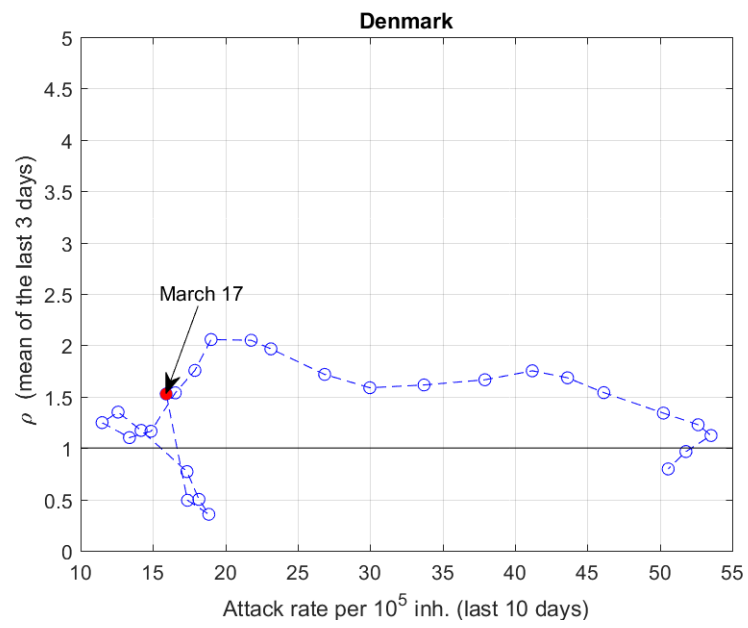
Deaths /
cumulated
reported cases

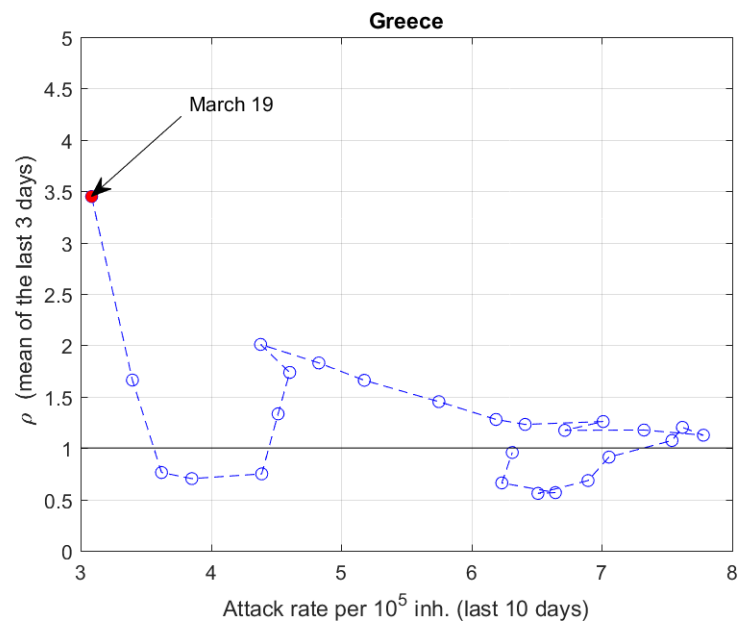
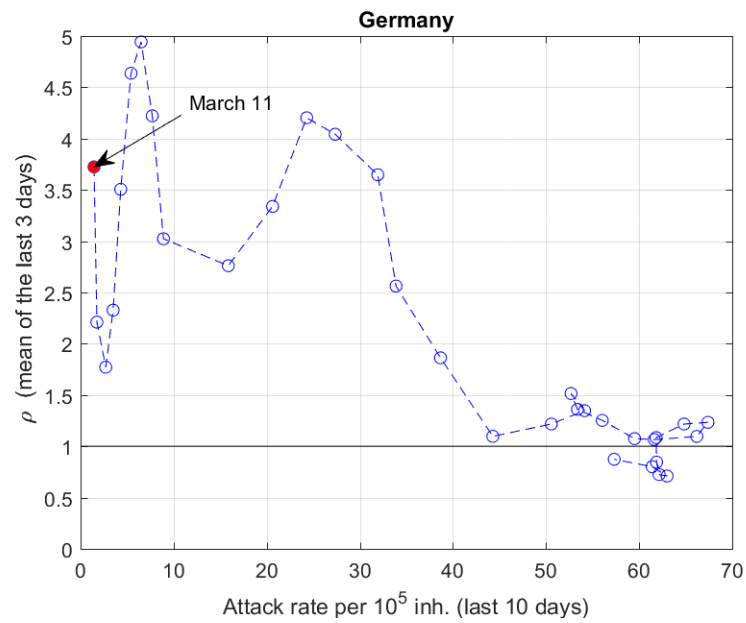
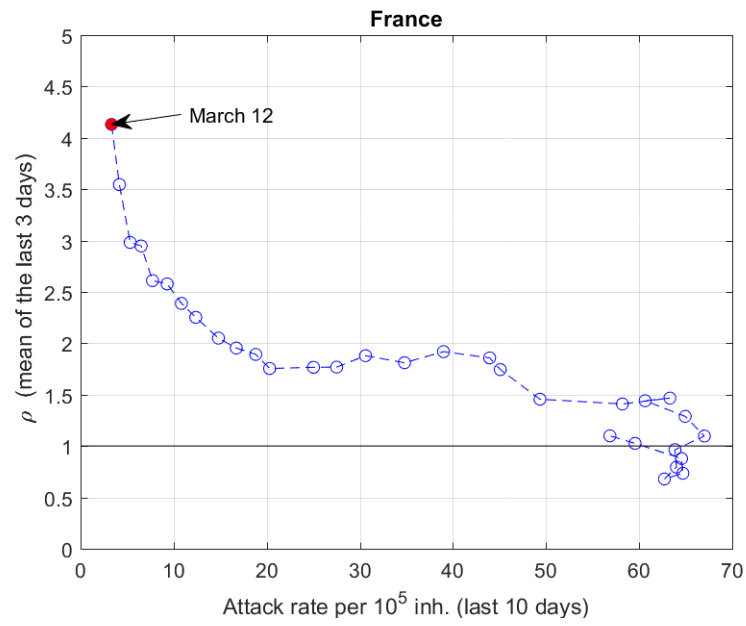


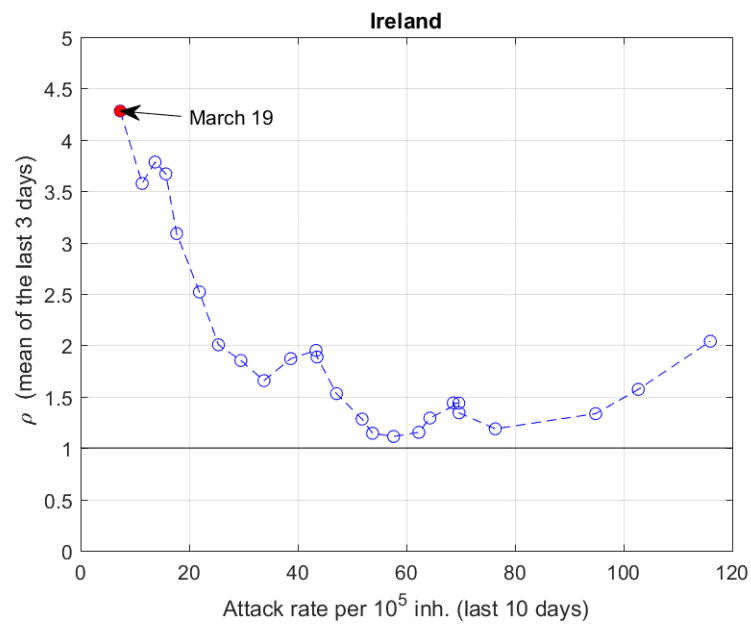
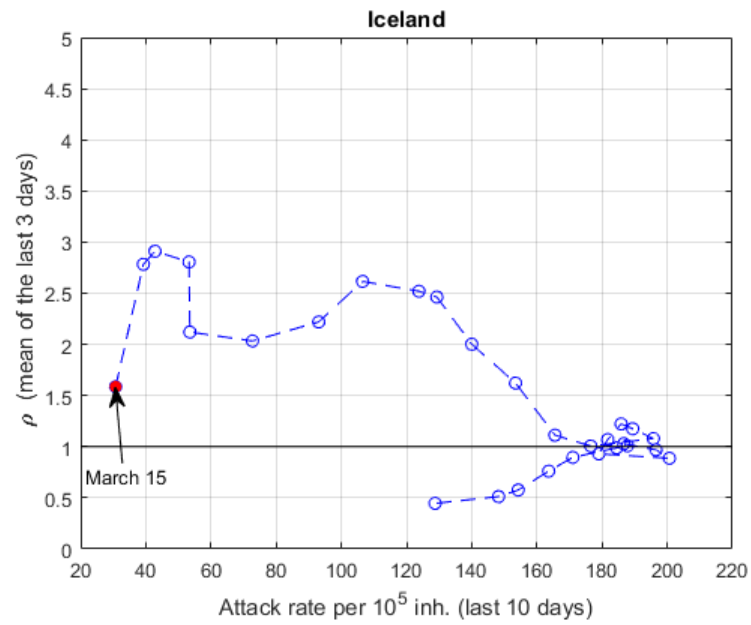
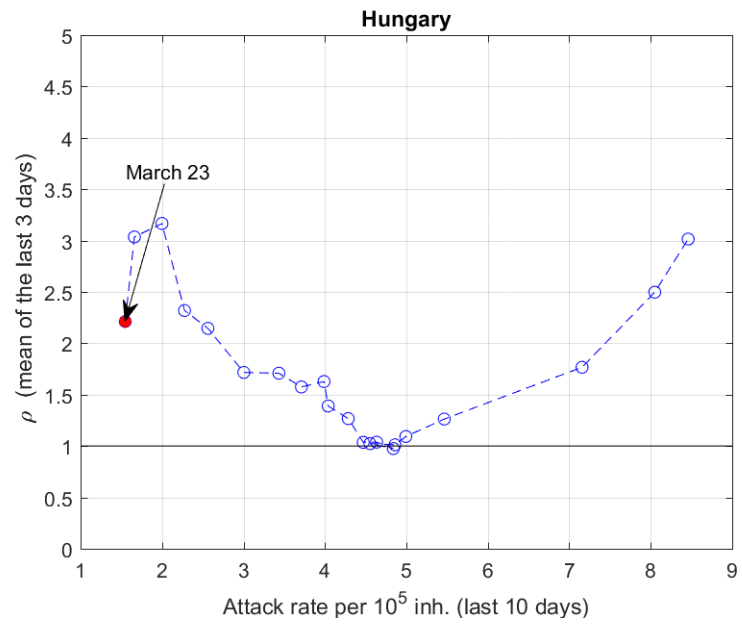
Risk diagrams of UE-EFTA-UK countries

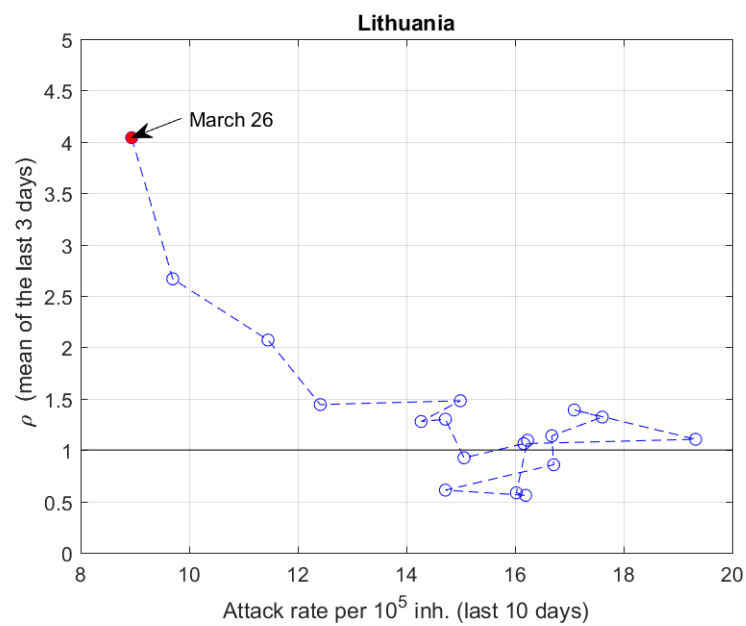
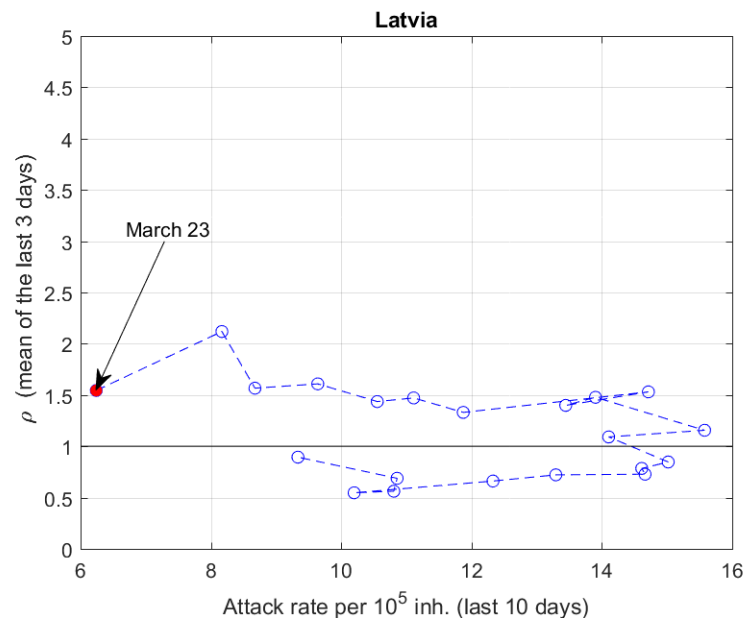
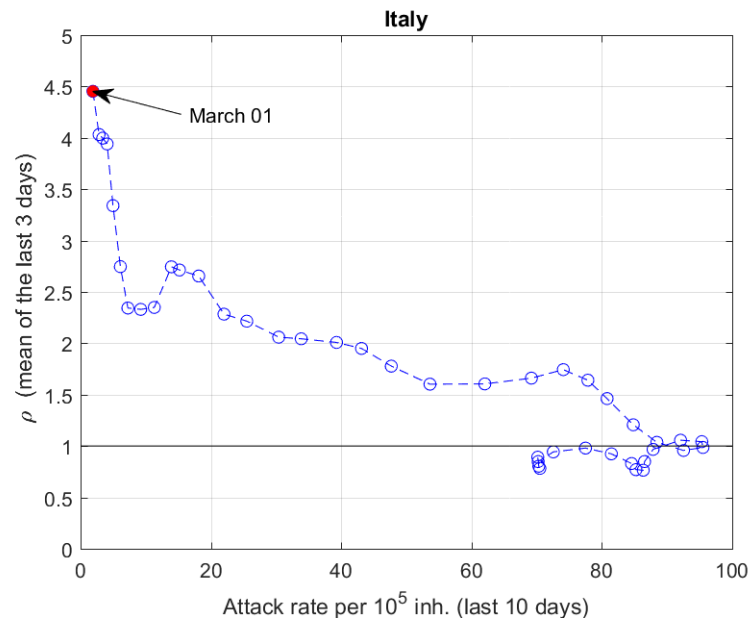


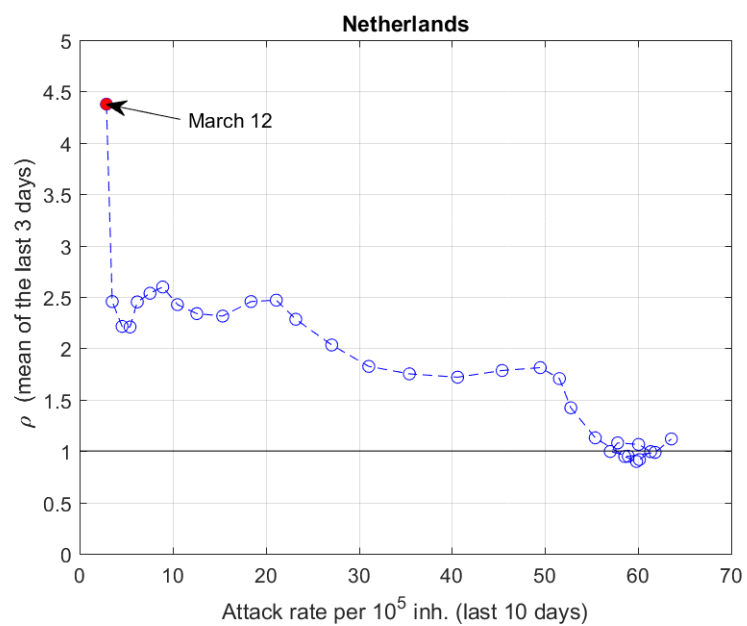
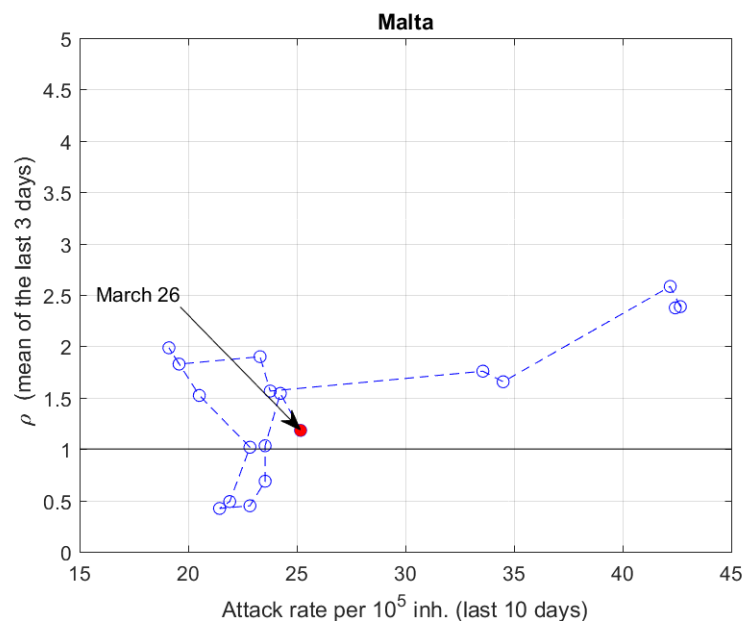
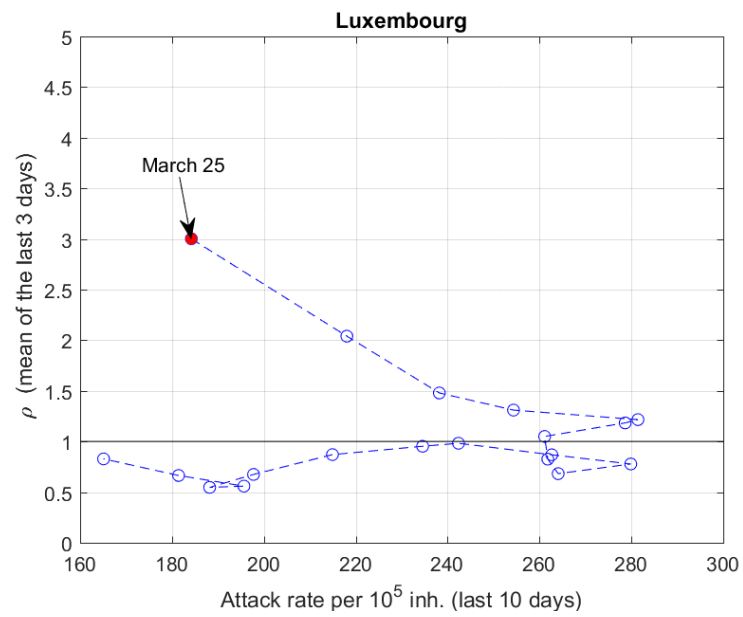


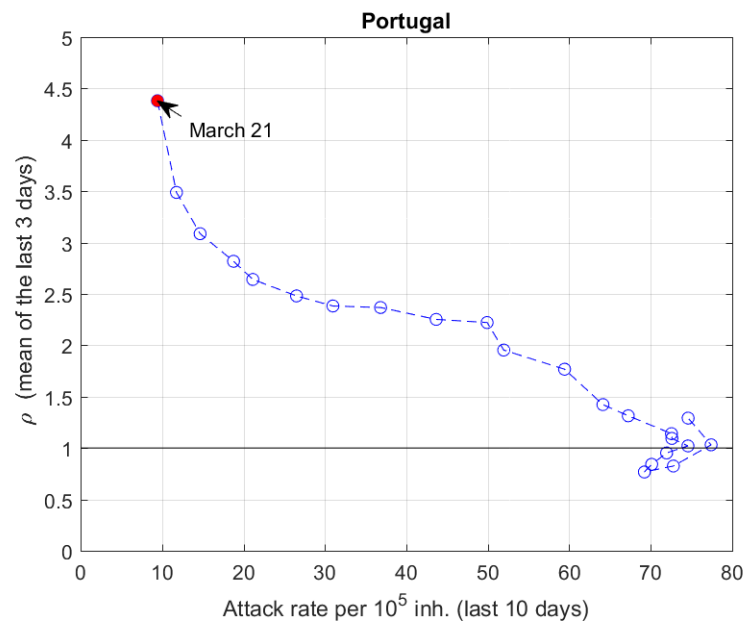
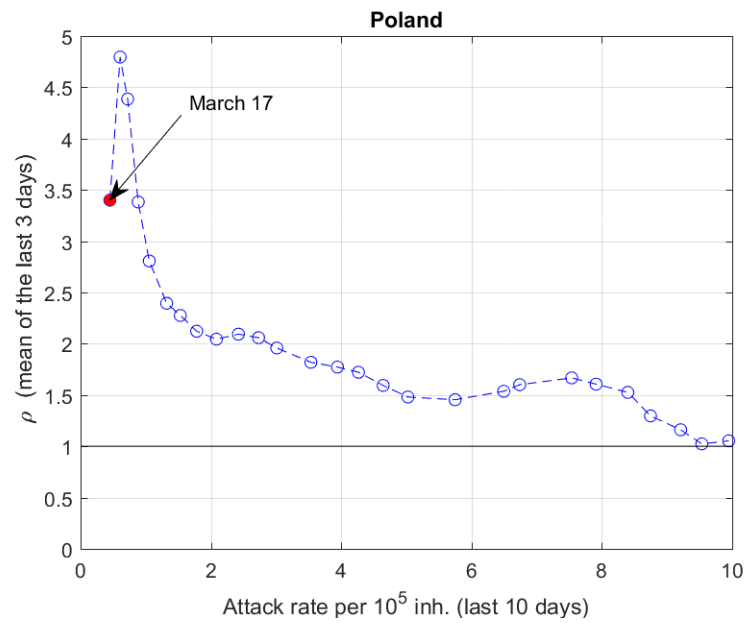
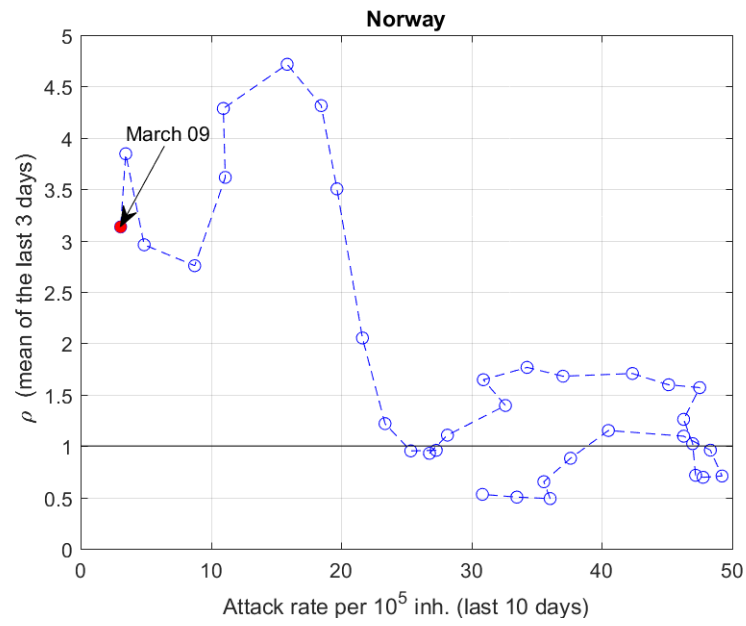


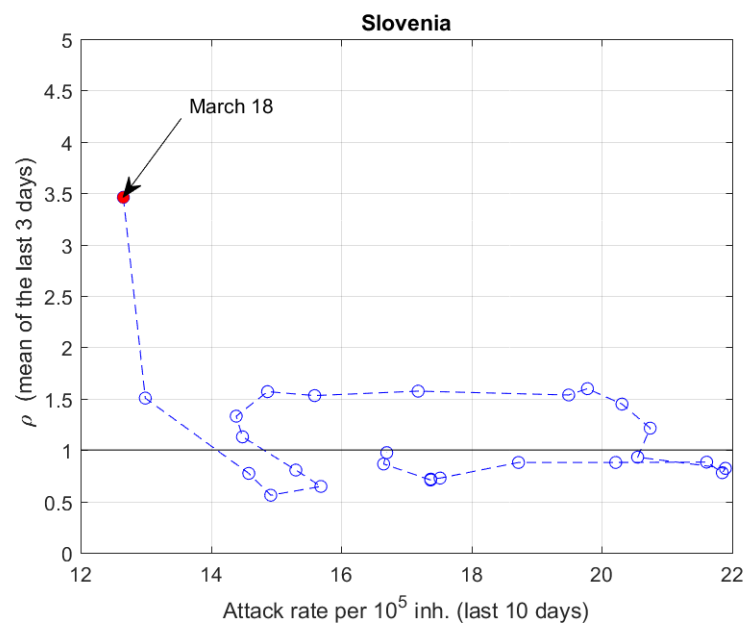
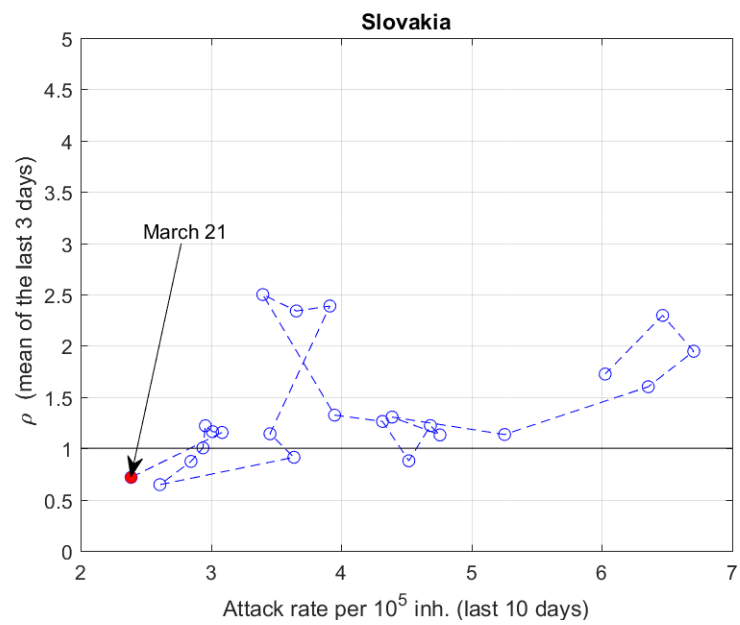
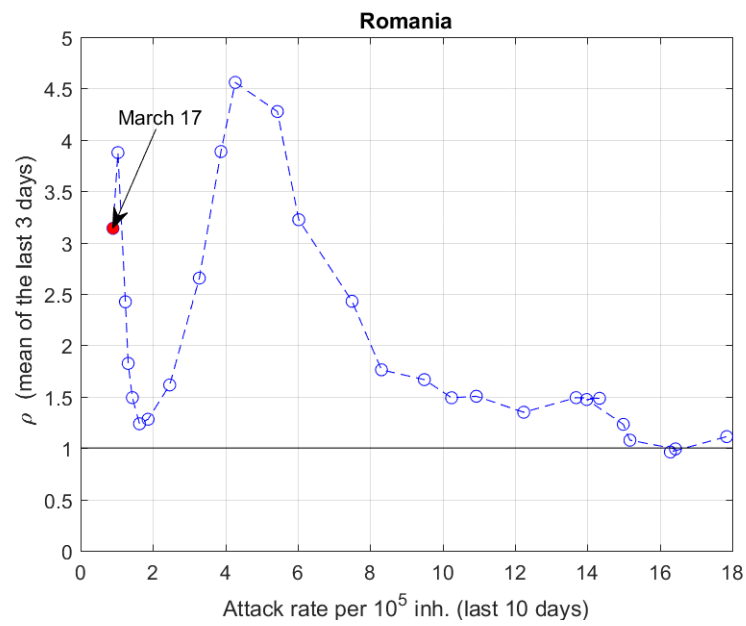


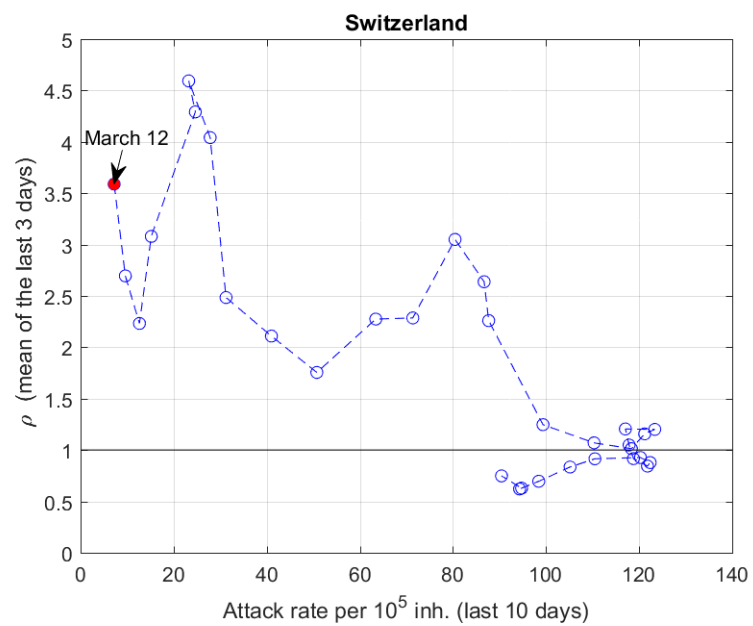
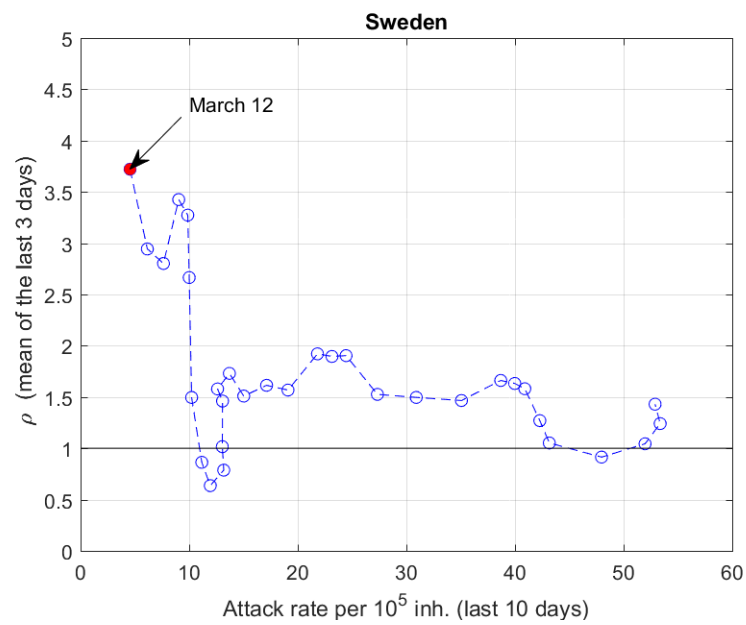
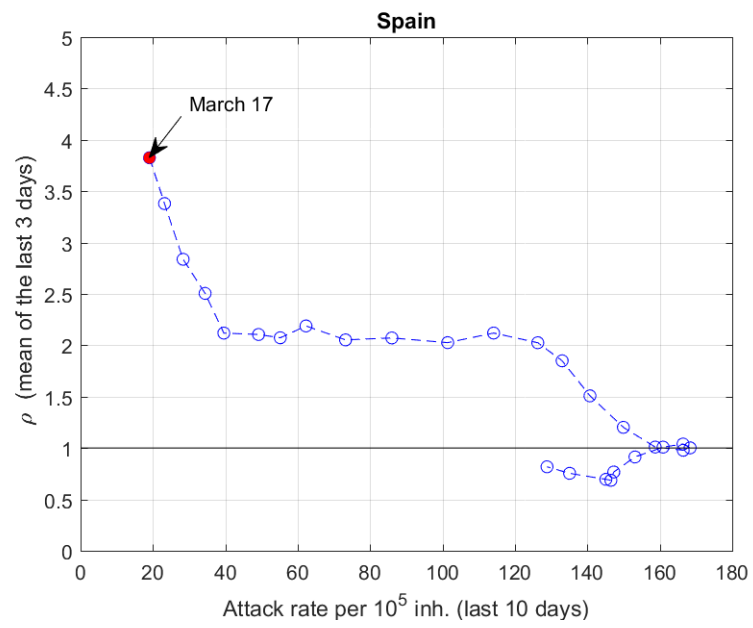


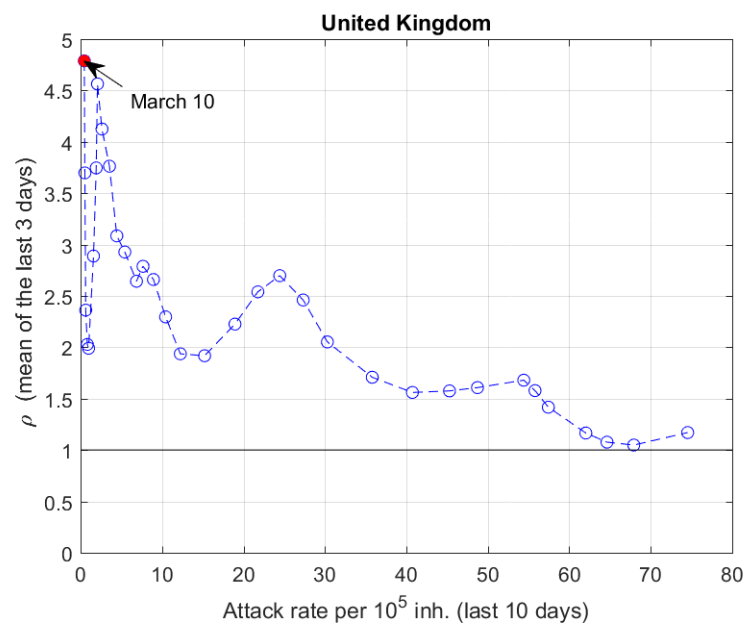






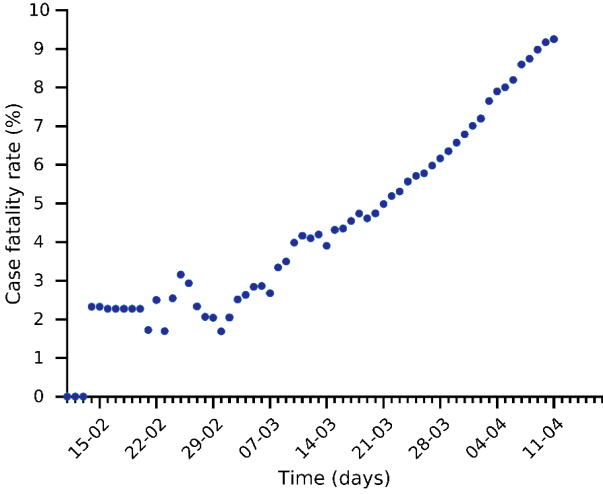
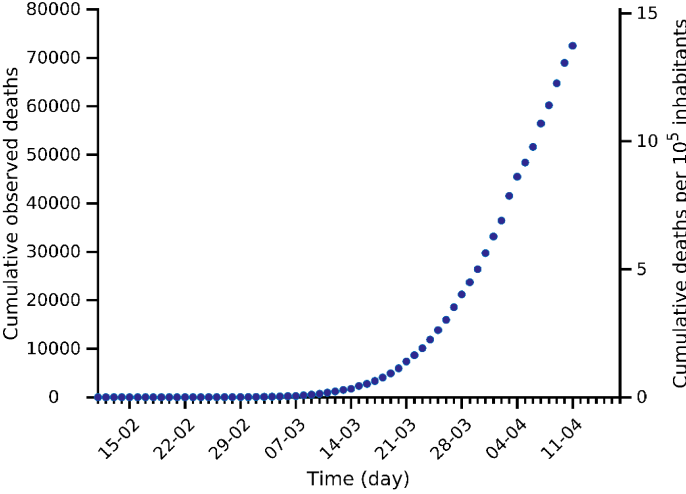
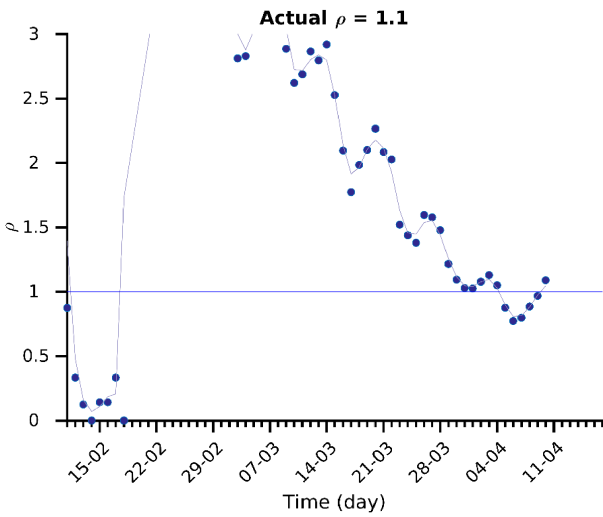
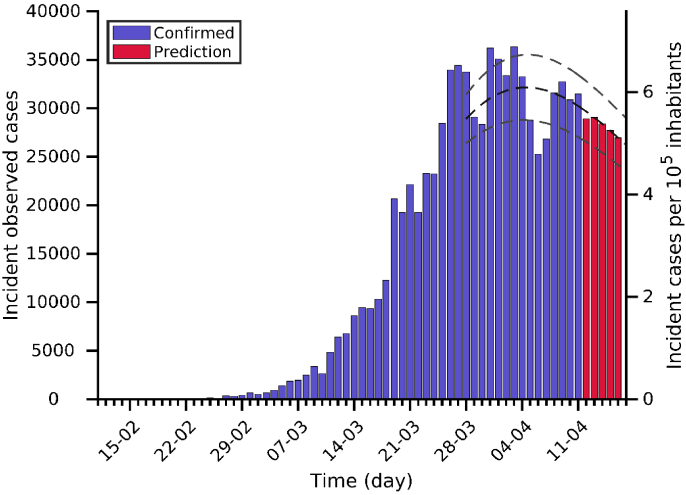
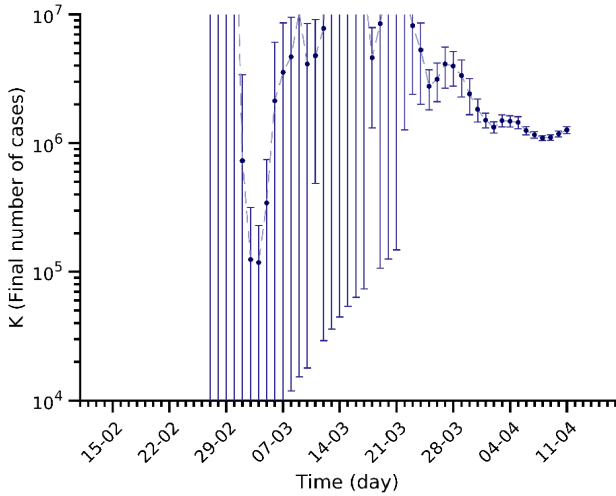
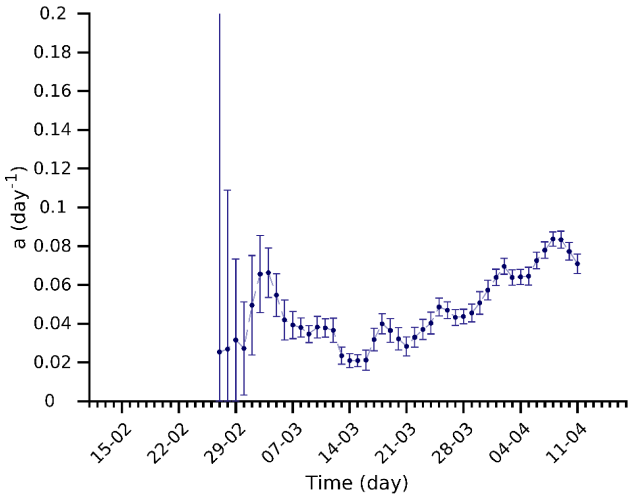
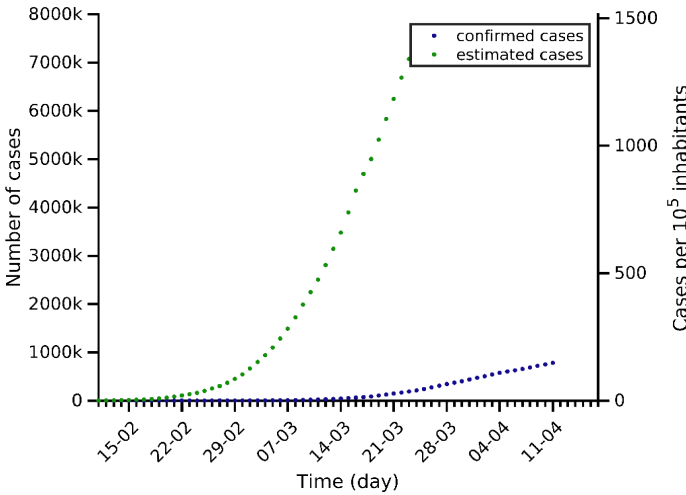
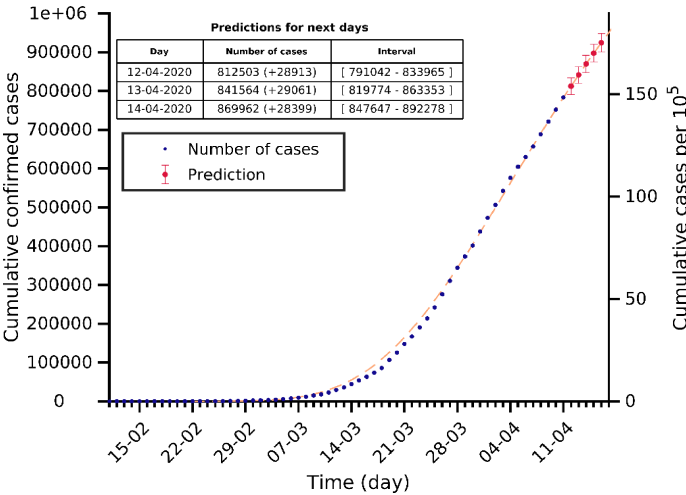




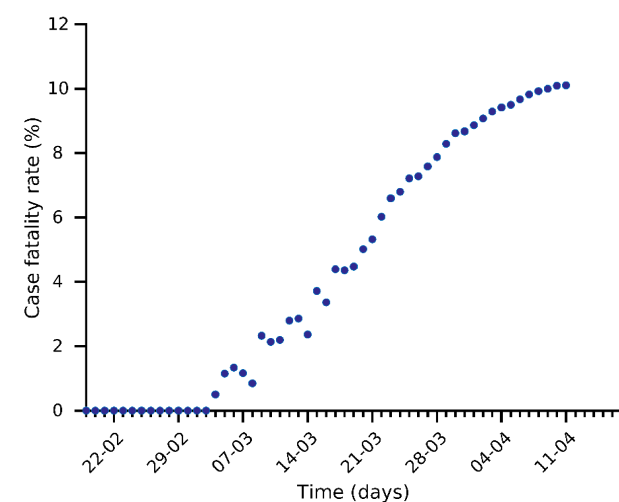
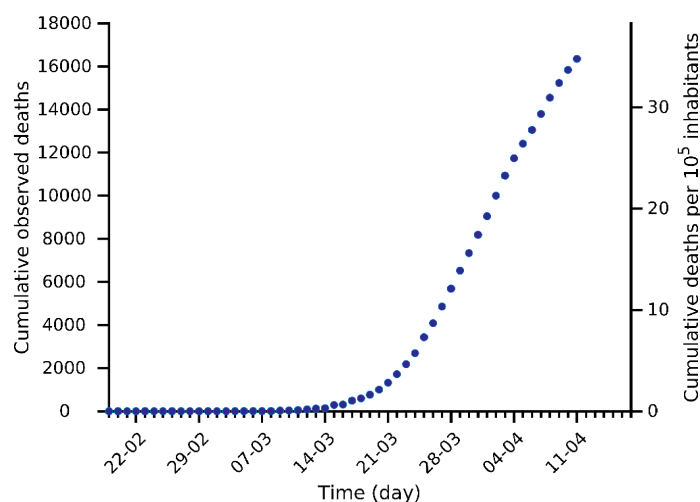
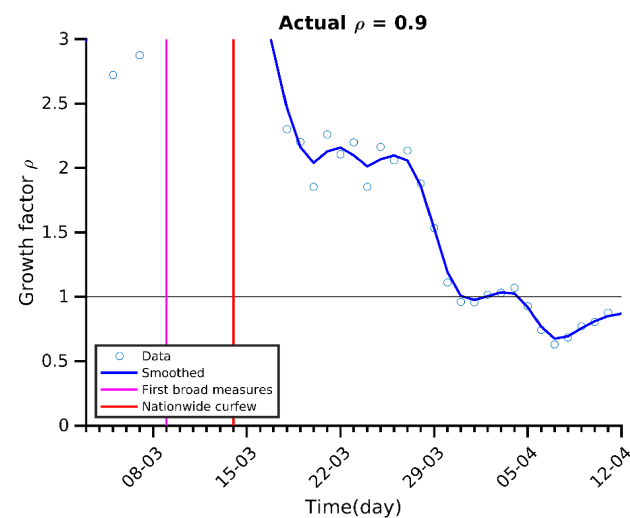
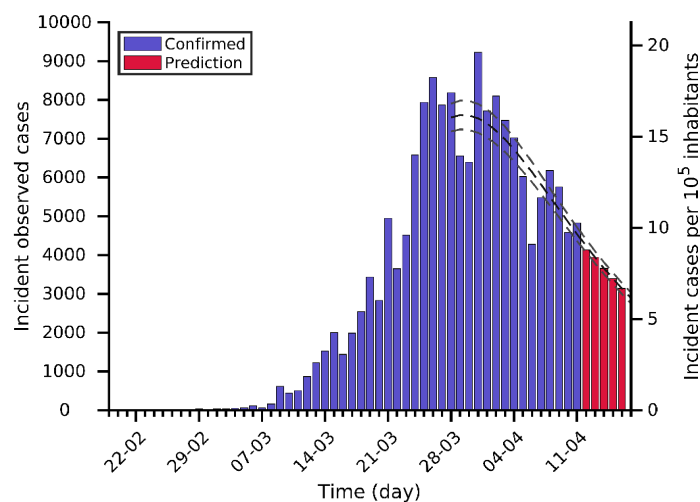
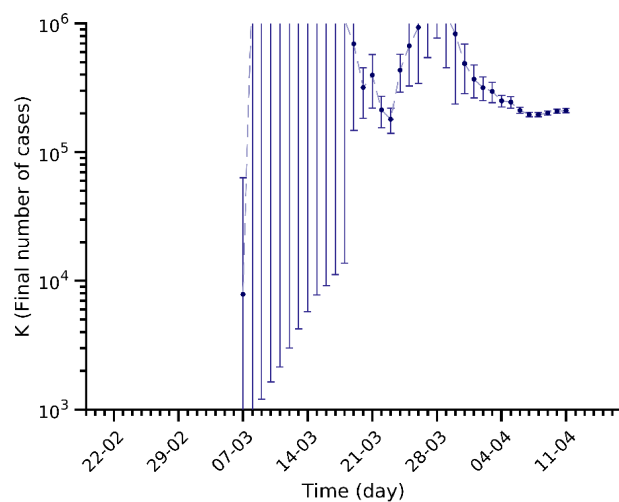
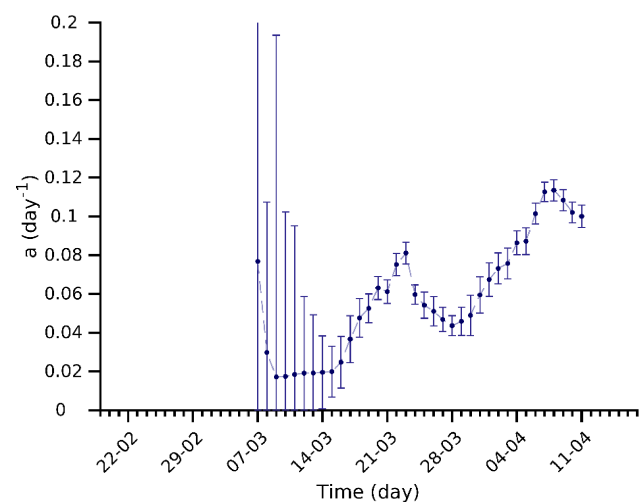
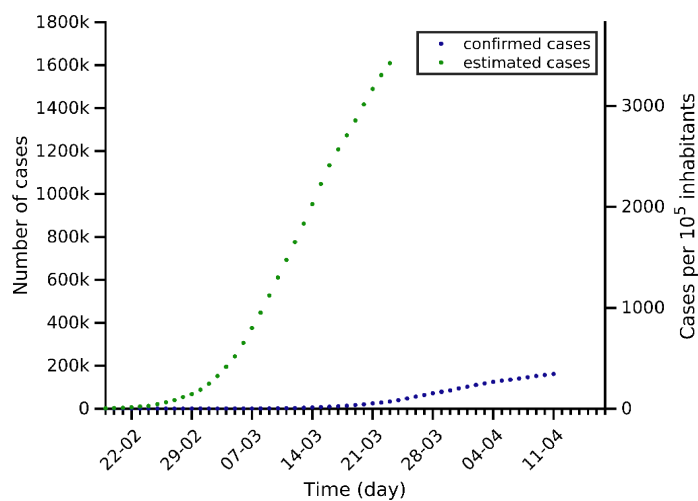
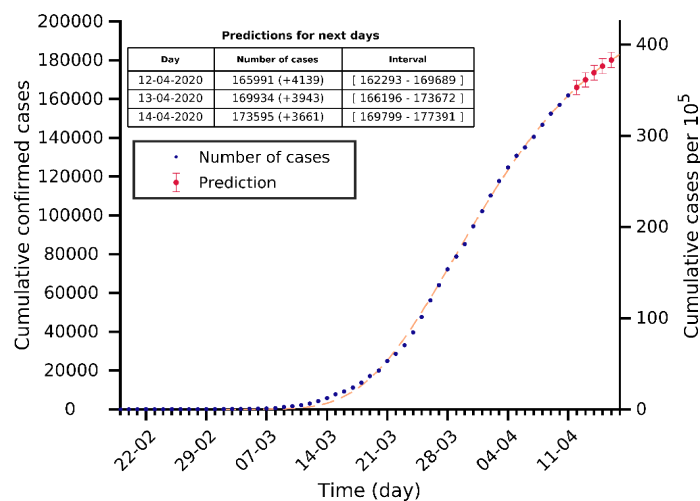


(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

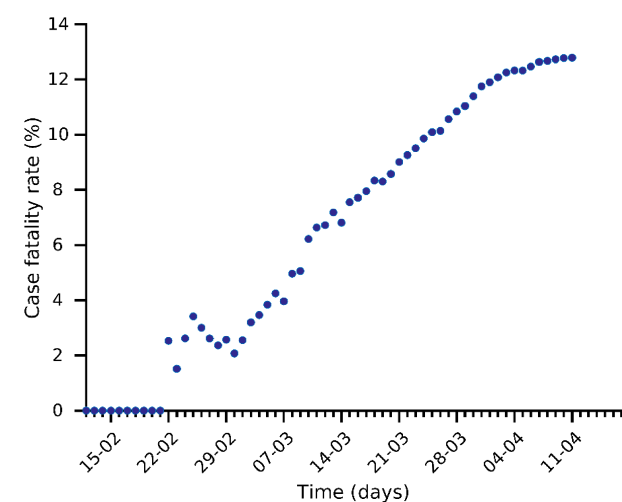
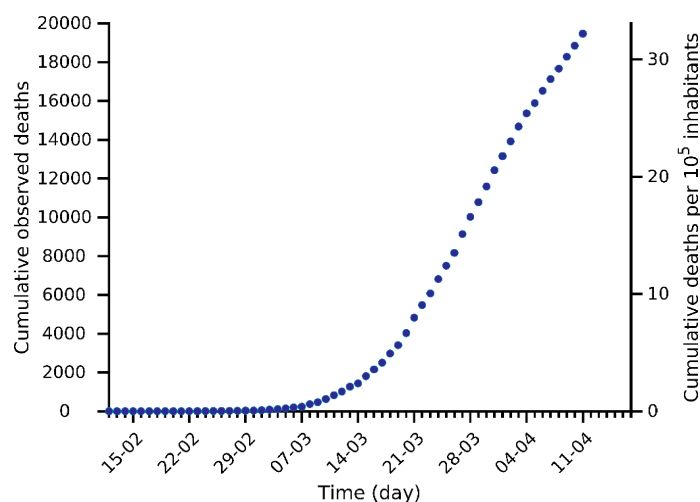
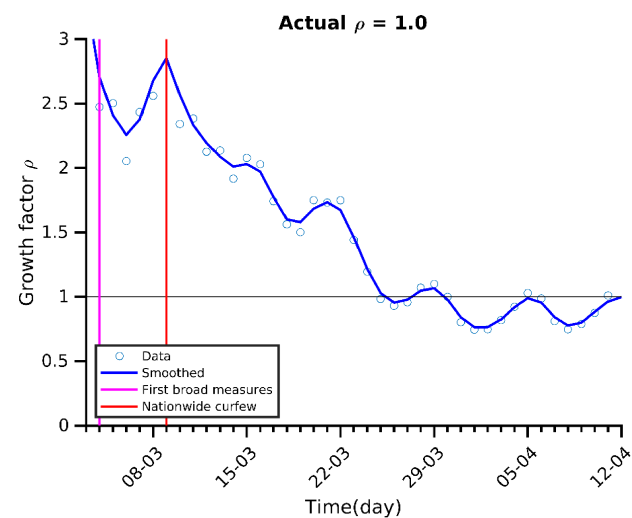
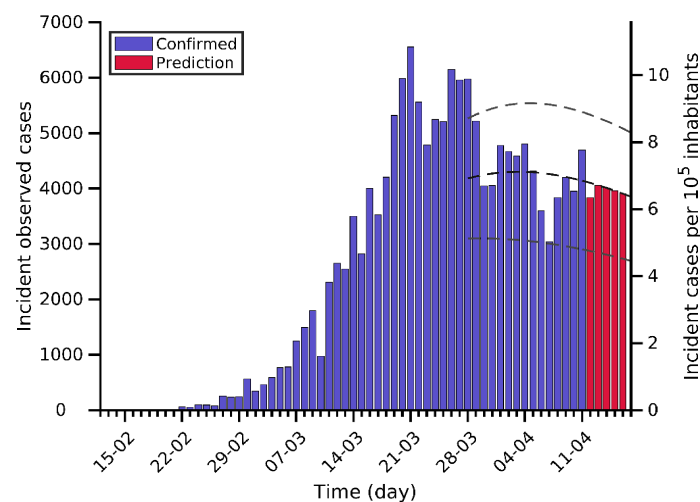
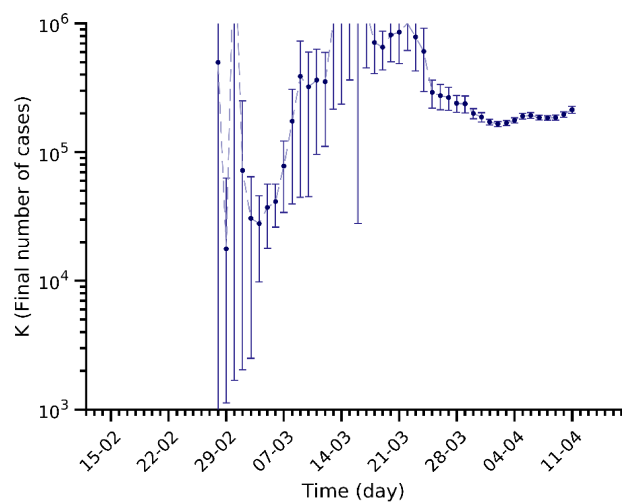
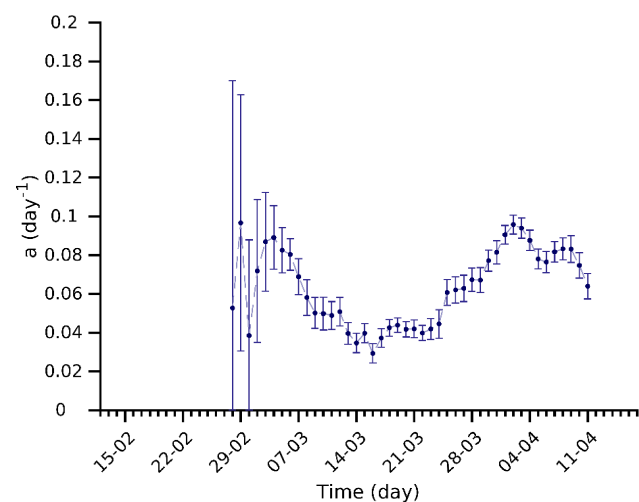
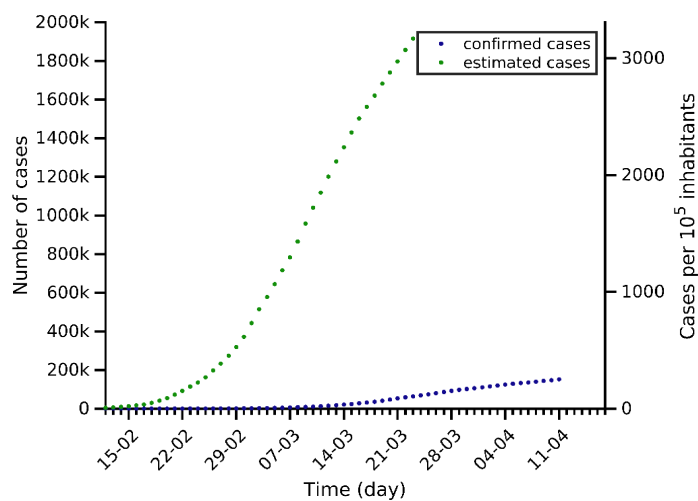
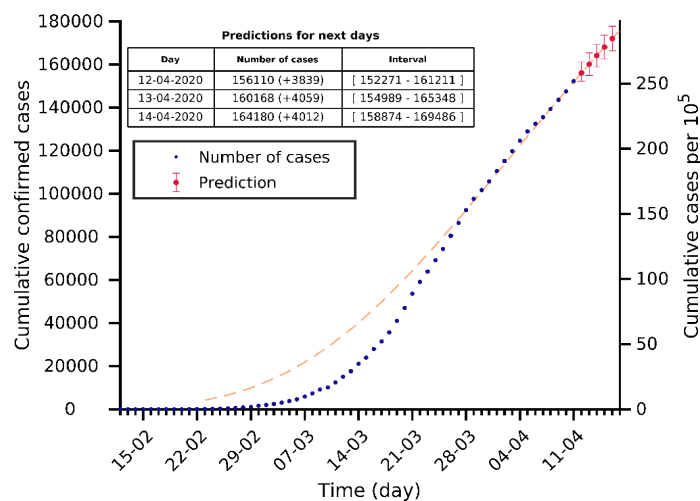
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>
<https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale> (Italy)



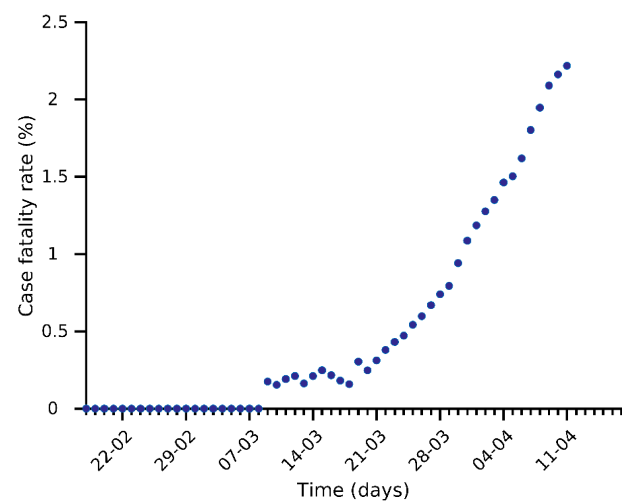
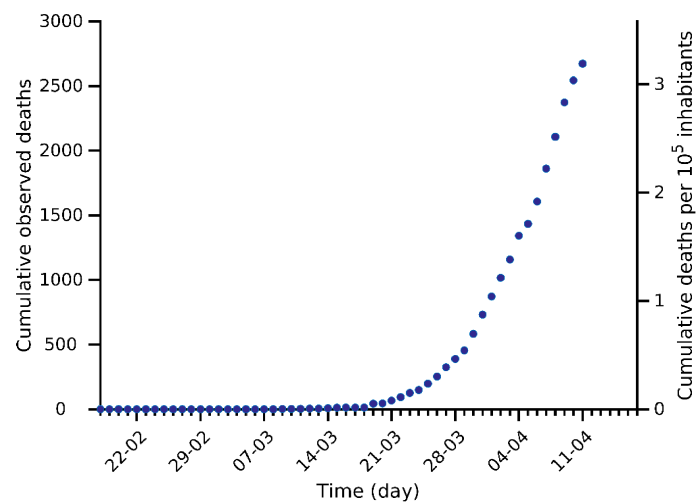
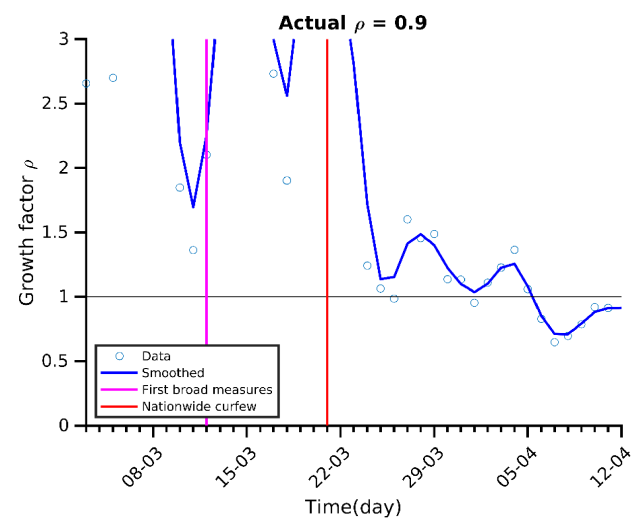
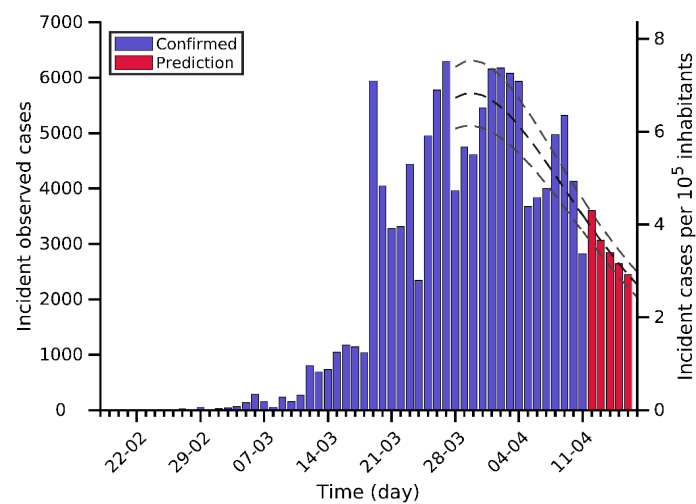
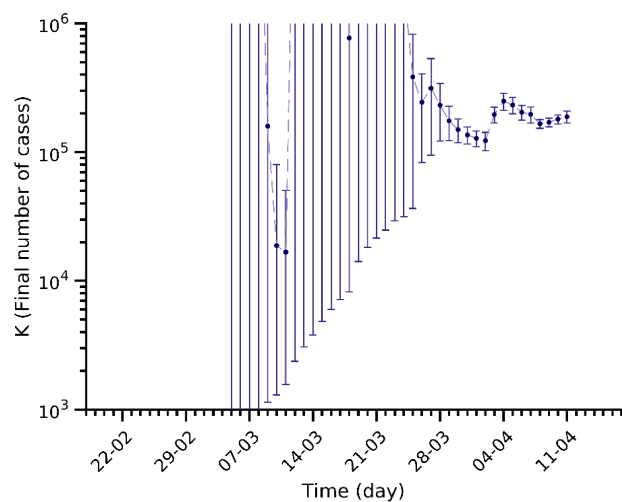
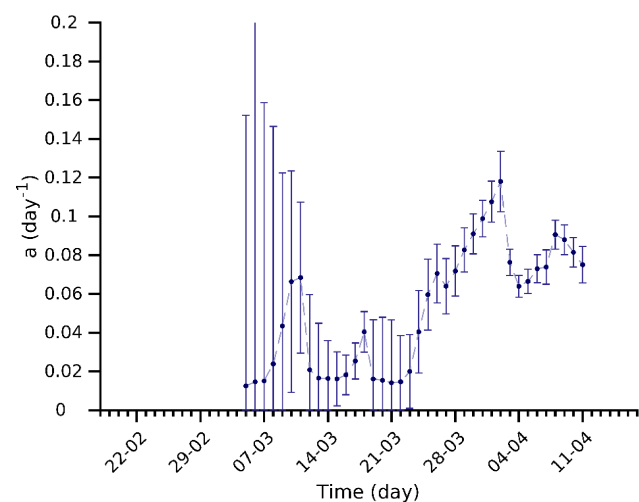
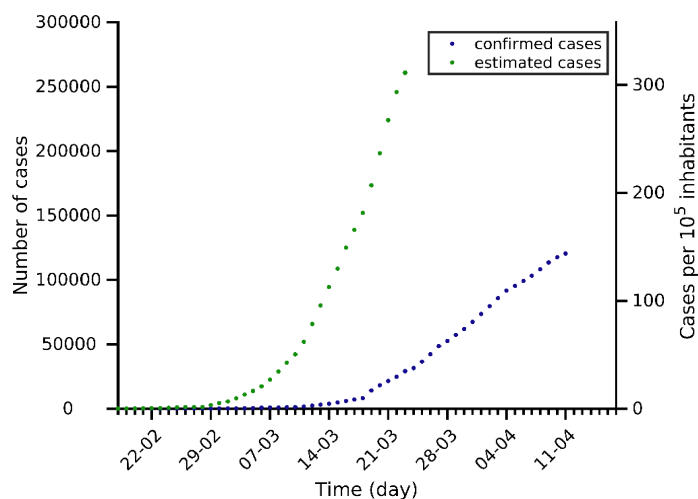
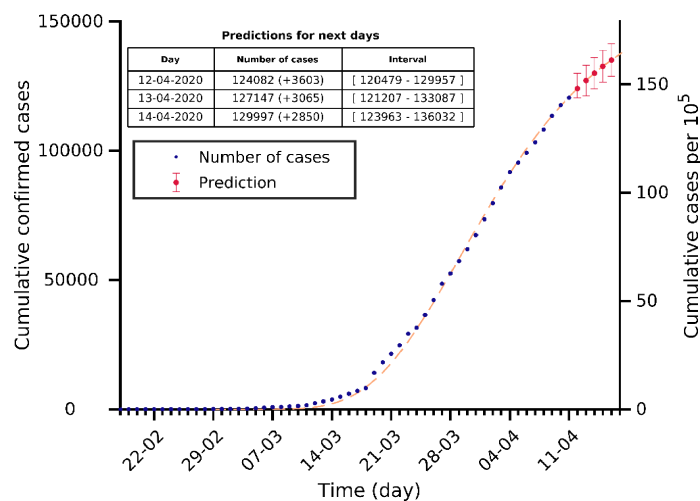
Spain 11-04-2020. Population: 47.0M. Current cumulated incidence: 344/10⁵



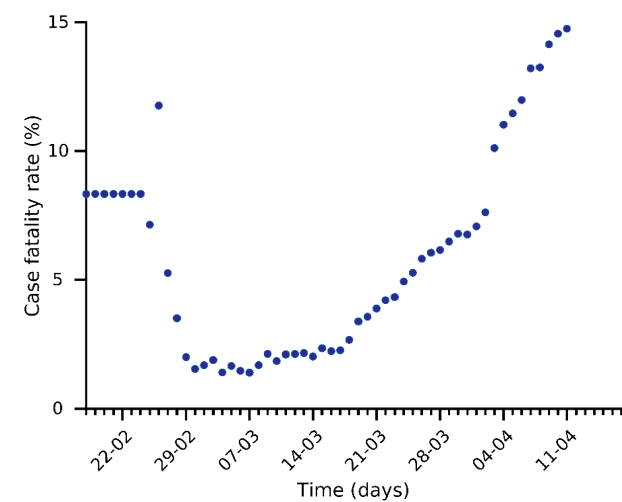
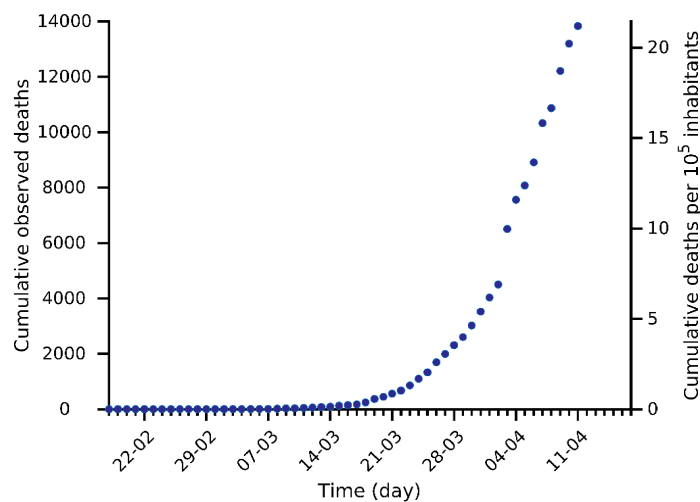
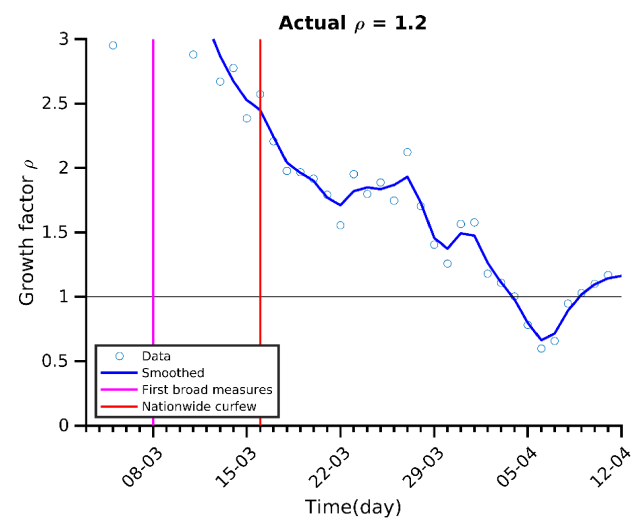
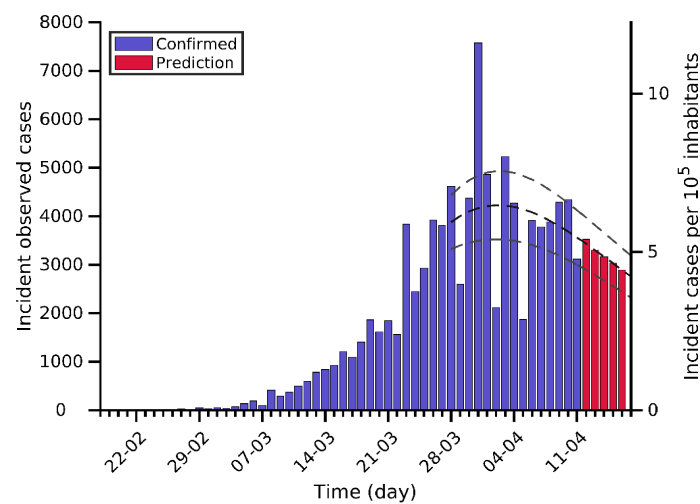
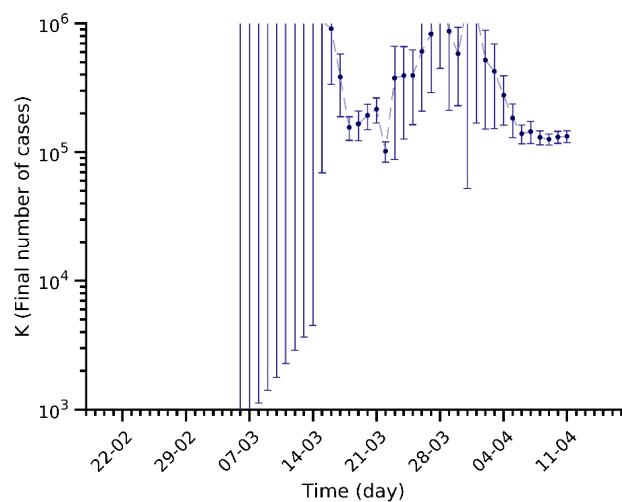
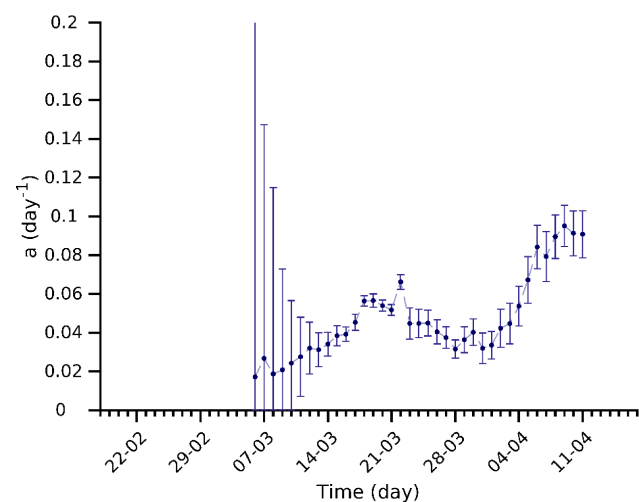
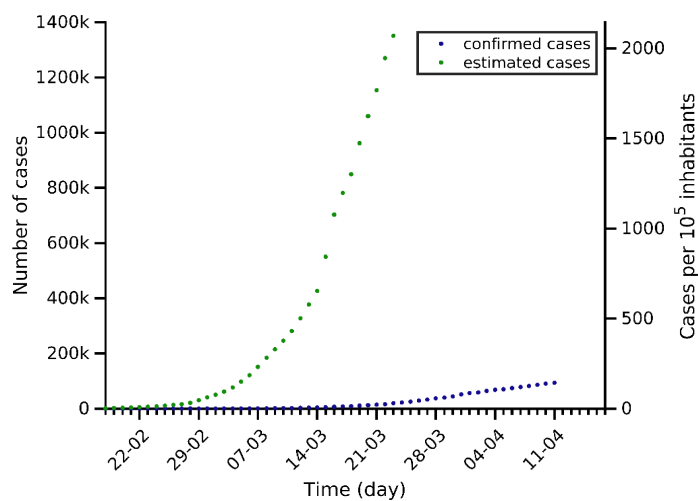
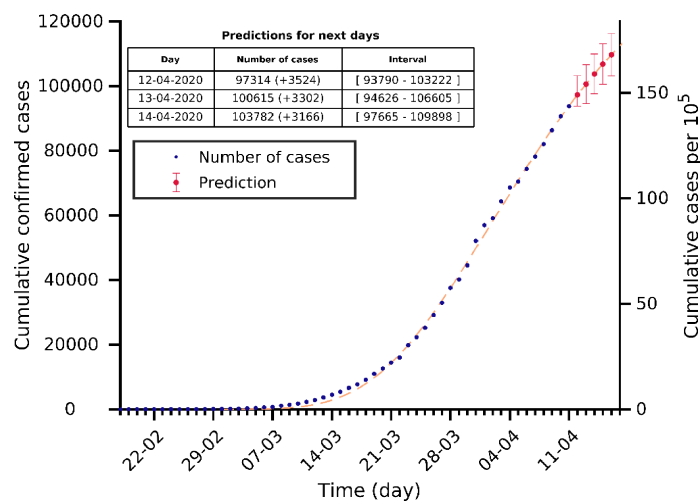
Italy 11-04-2020. Population: 60.5M. Current cumulated incidence: 252/10⁵



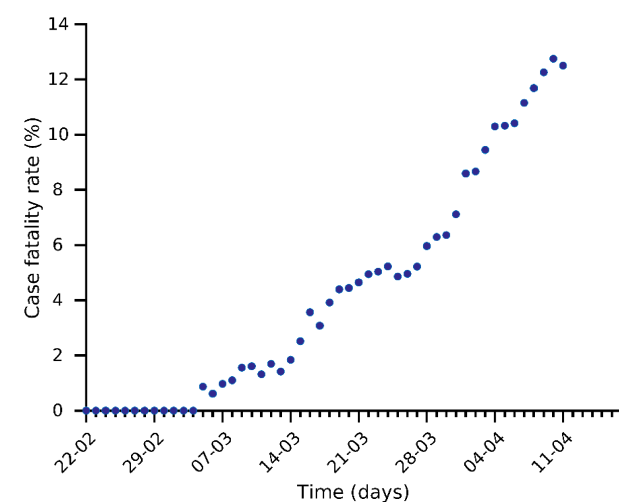
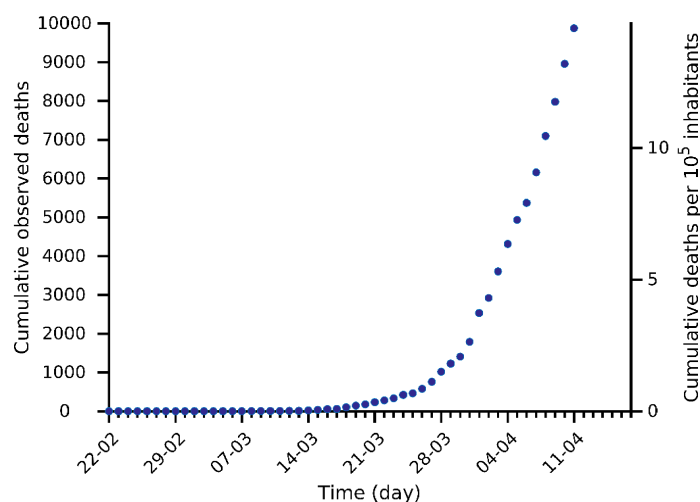
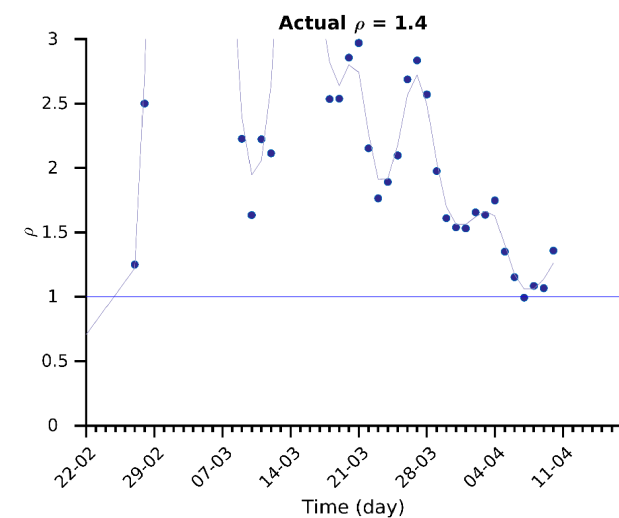
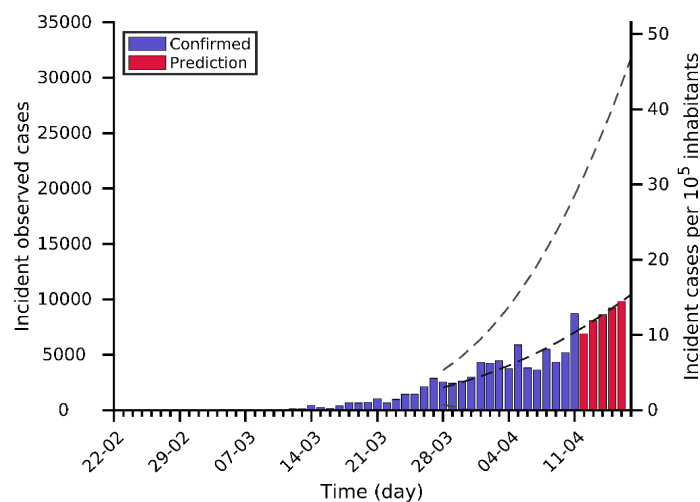
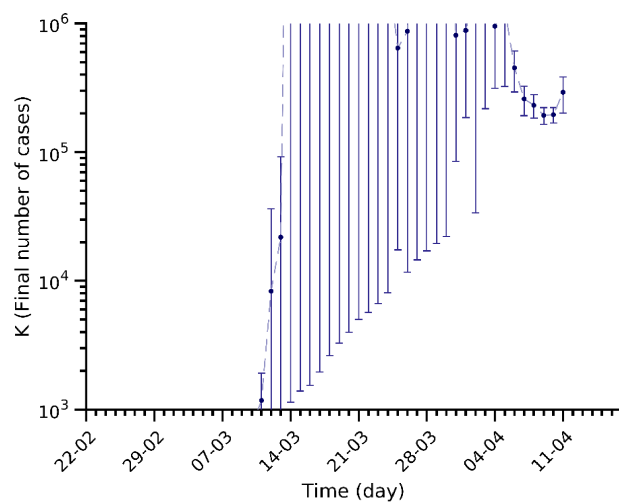
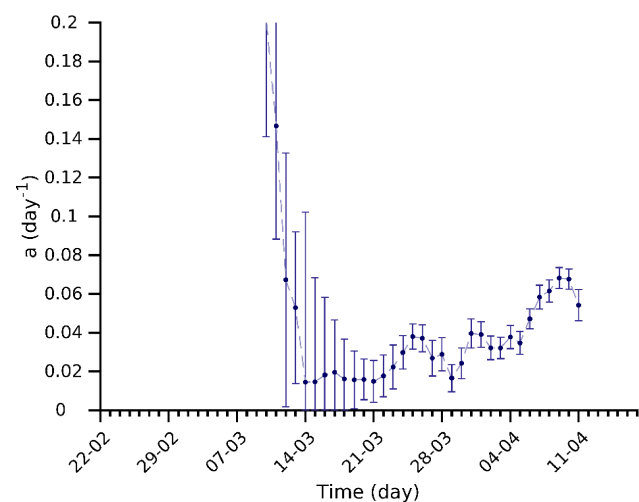
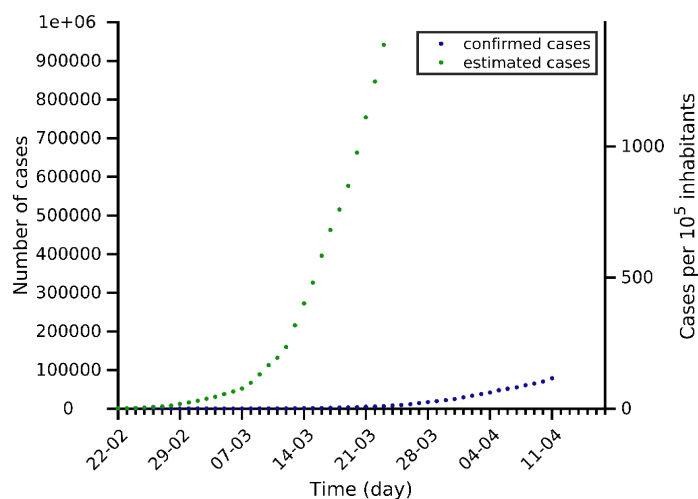
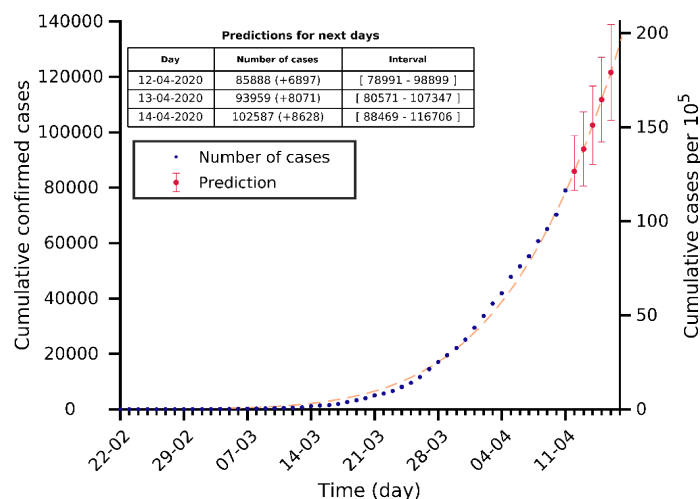
Germany 11-04-2020. Population: 83.8M. Current cumulated incidence: 144/10⁵



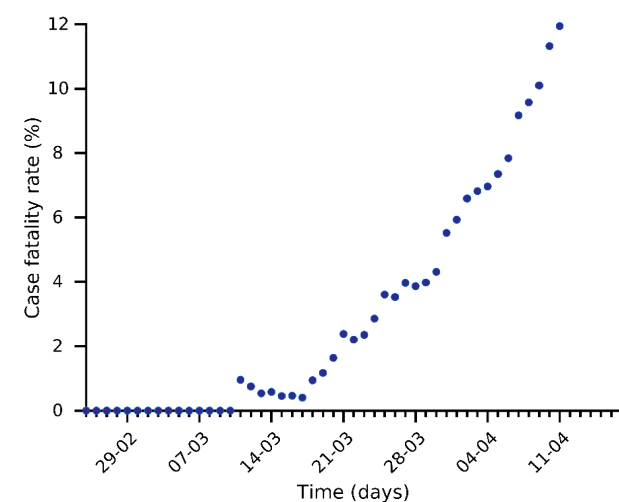
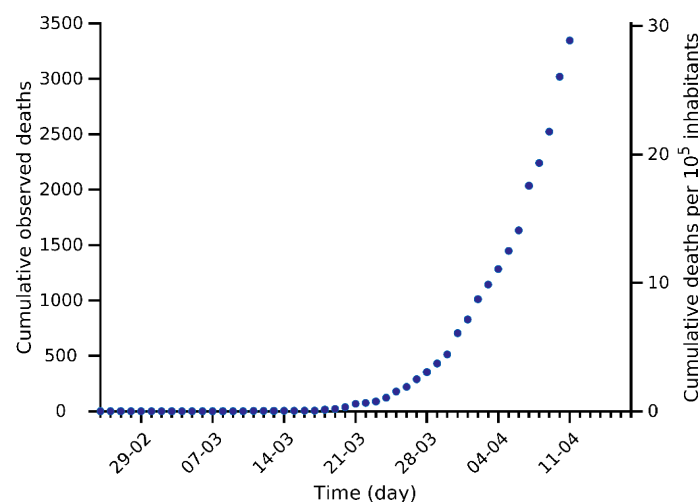
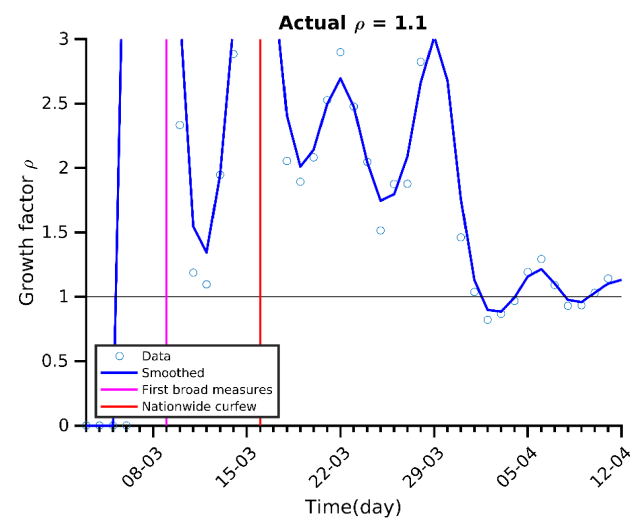
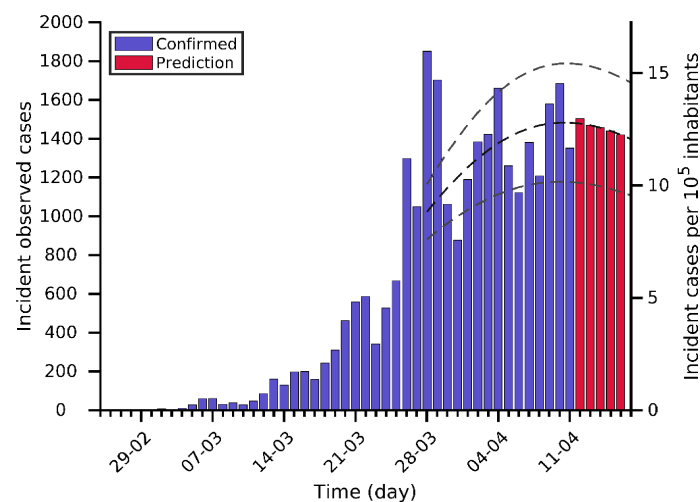
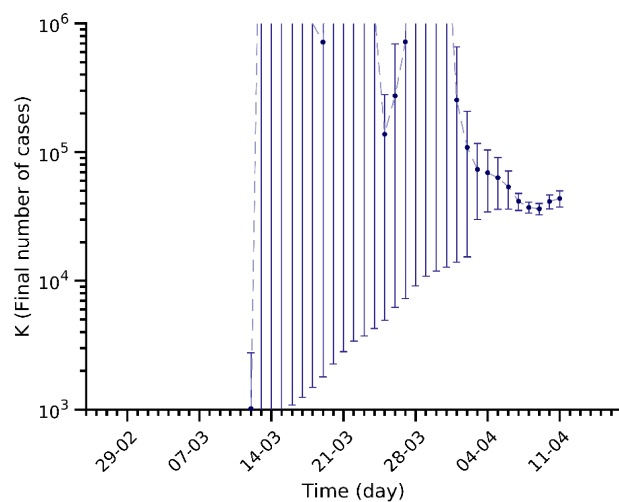
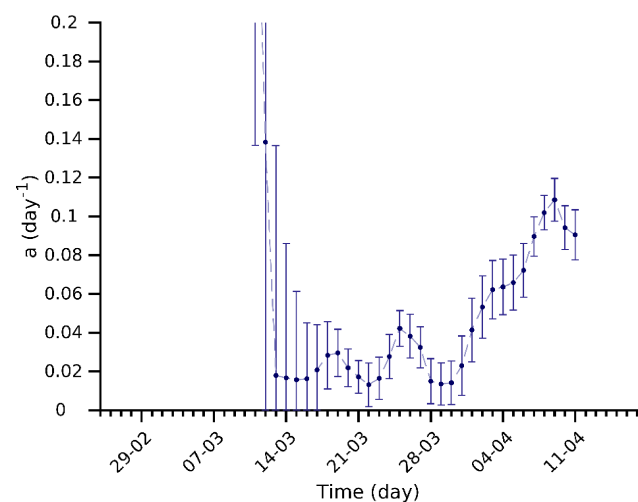
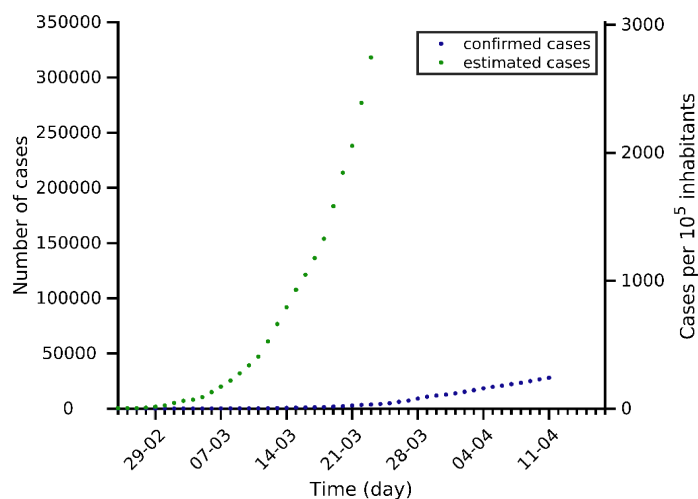
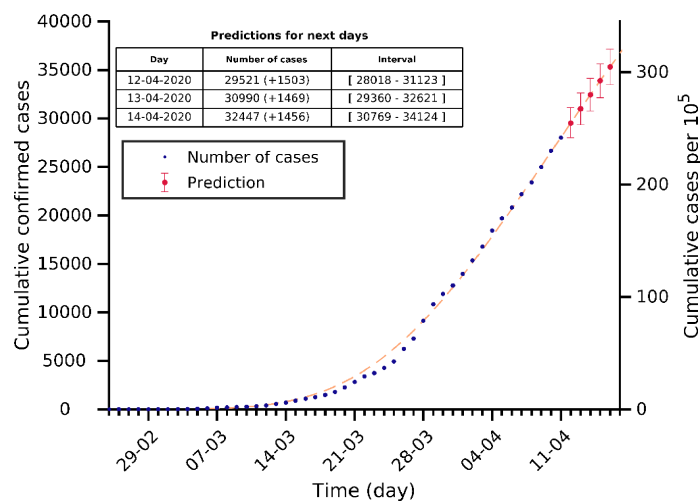
France 11-04-2020. Population: 65.3M. Current cumulated incidence: 144/10⁵



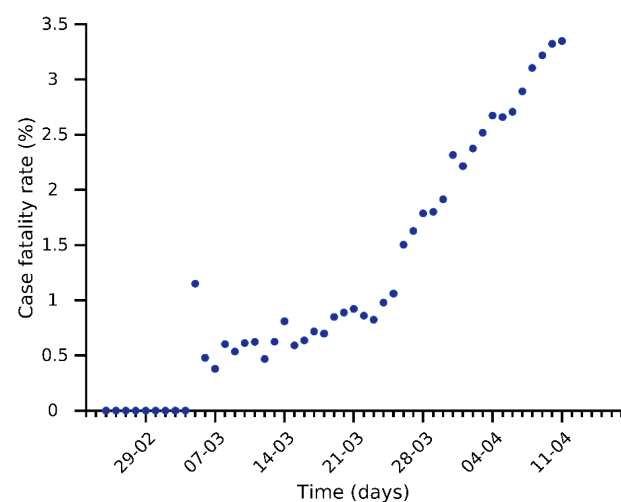
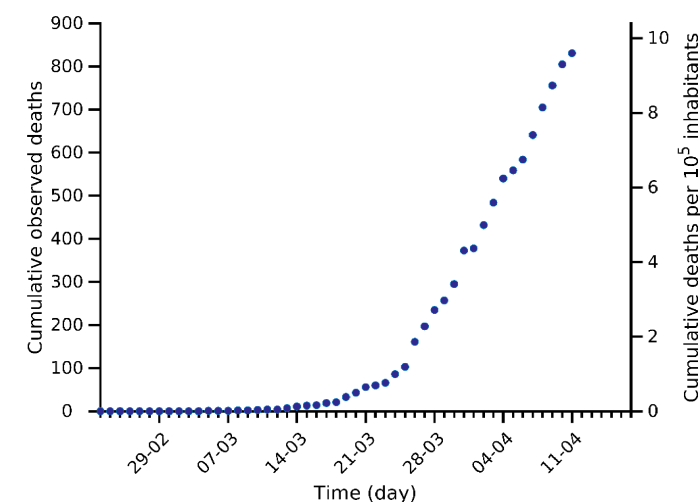
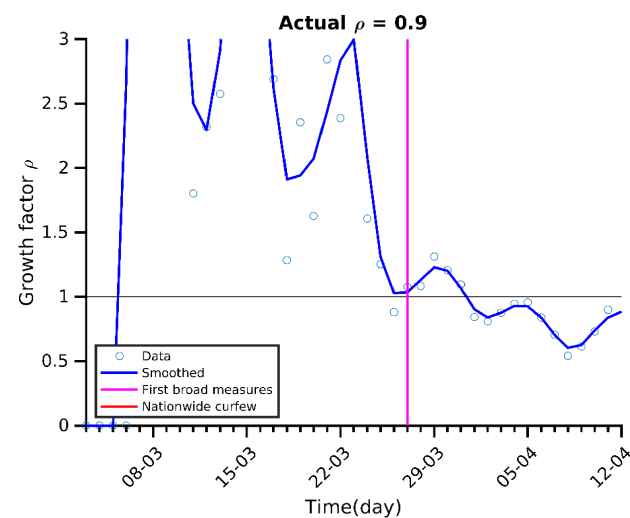
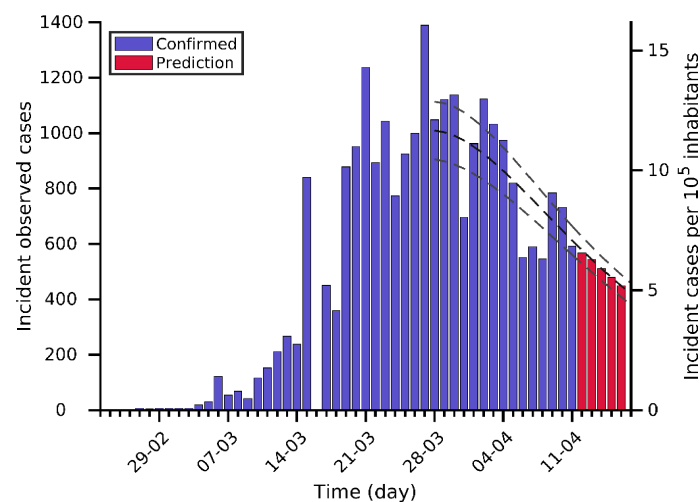
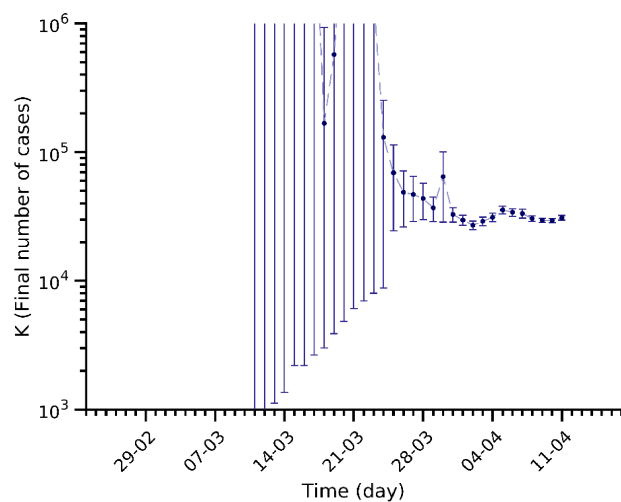
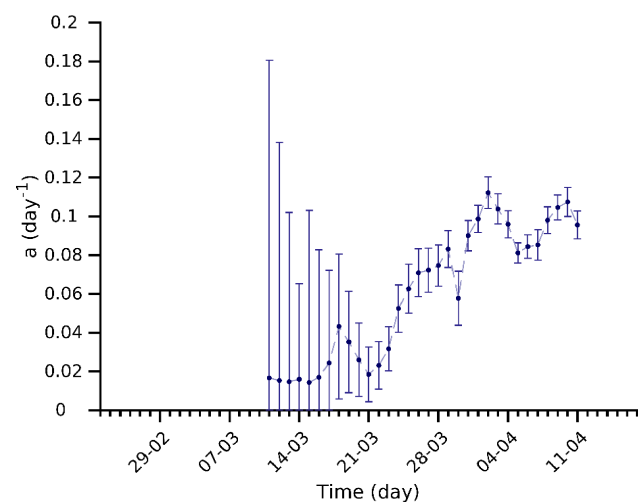
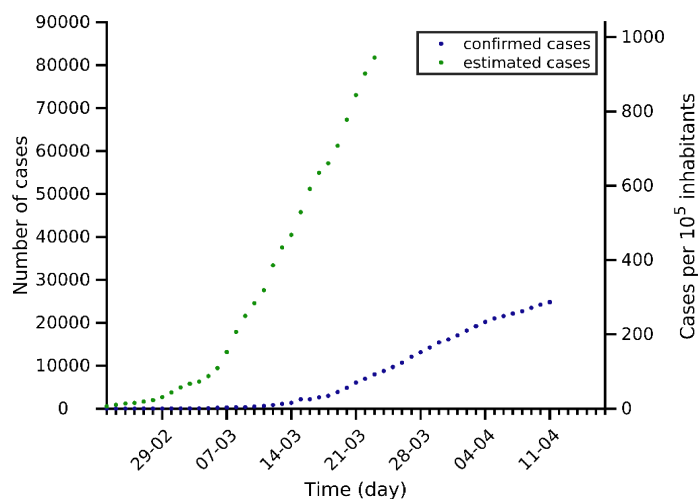
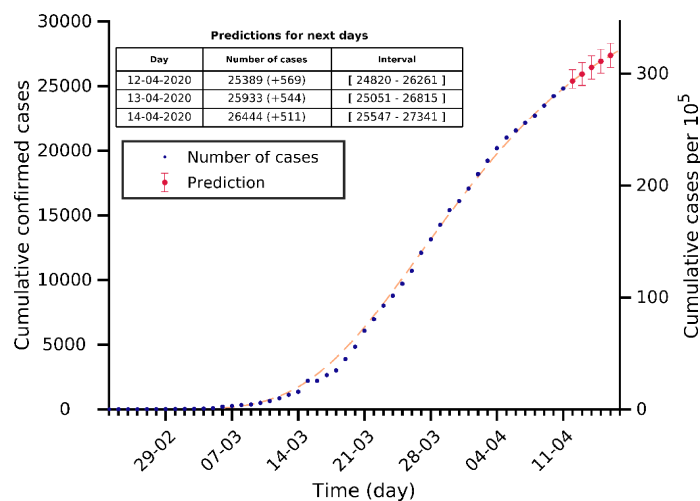
UK 11-04-2020. Population: 67.9M. Current cumulated incidence: 116/10⁵



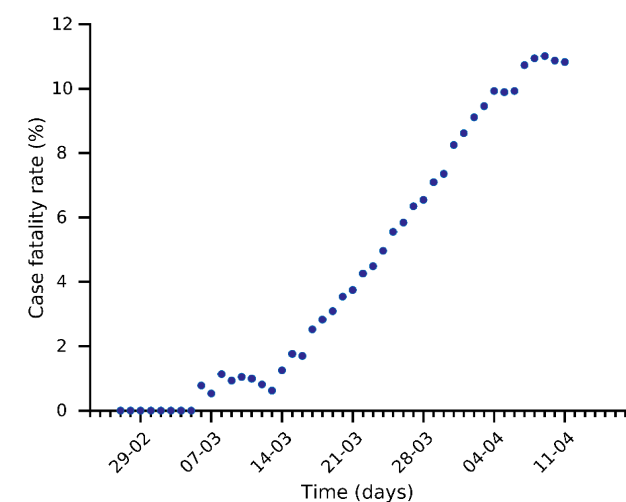
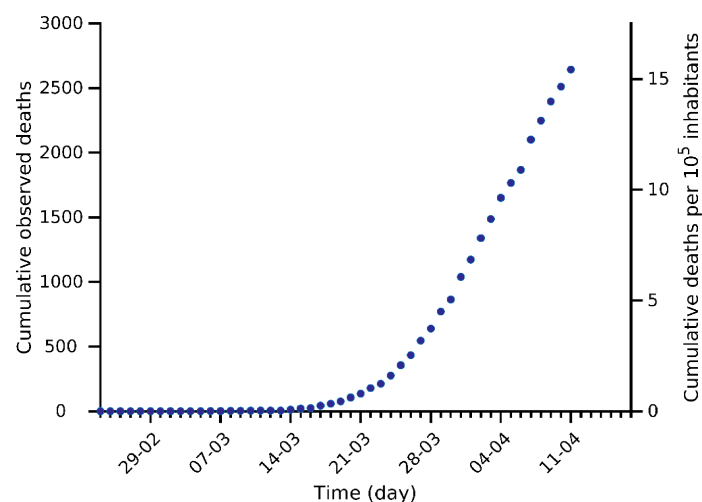
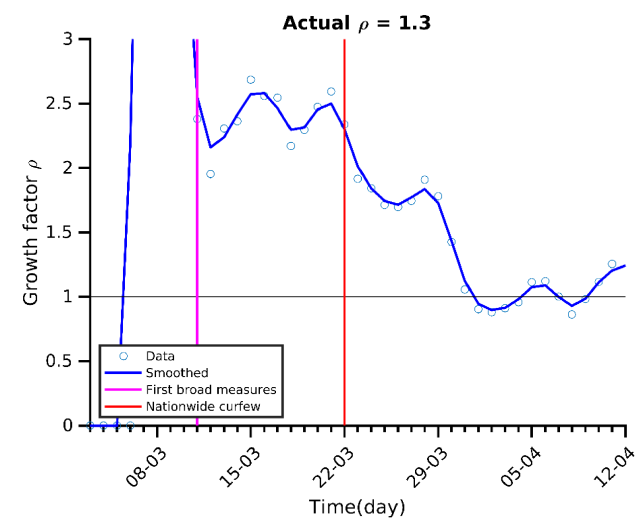
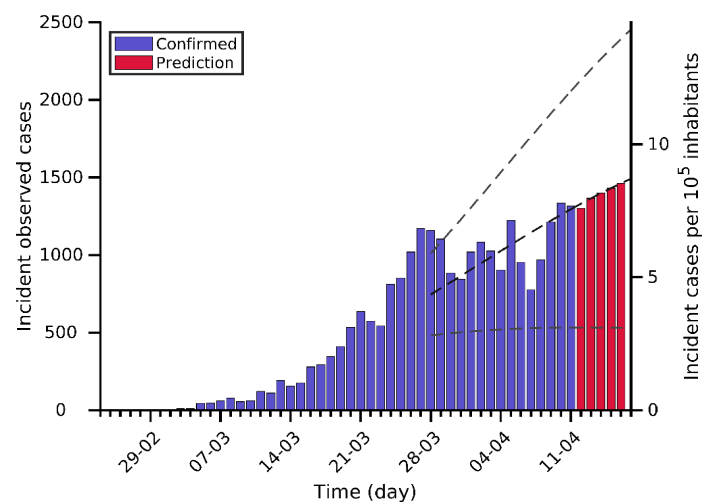
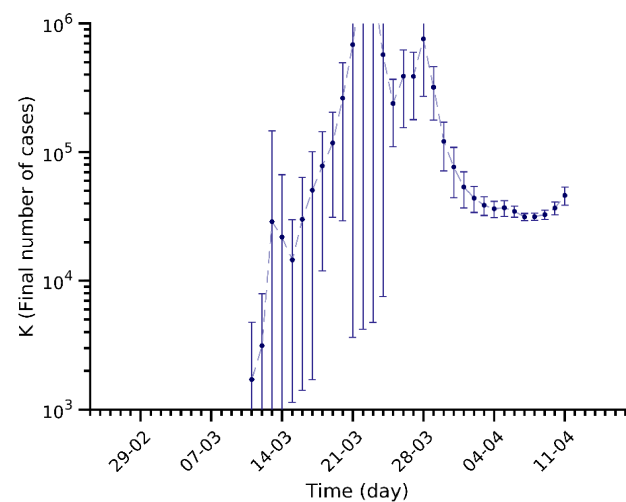
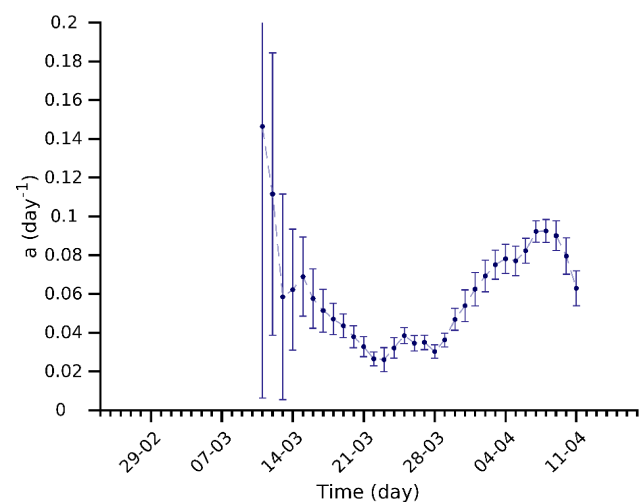
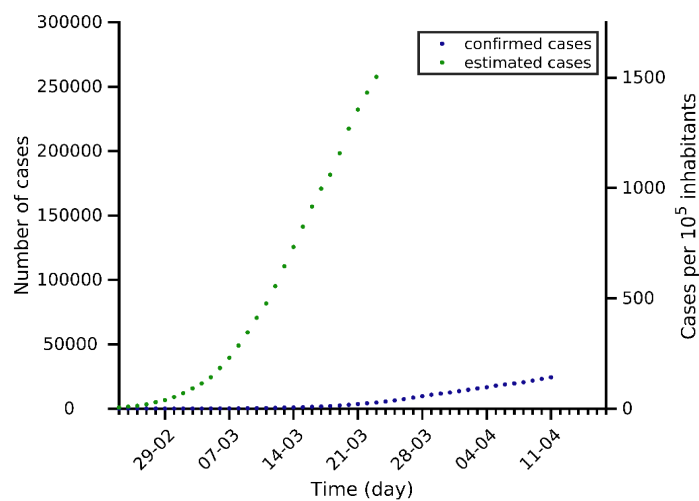
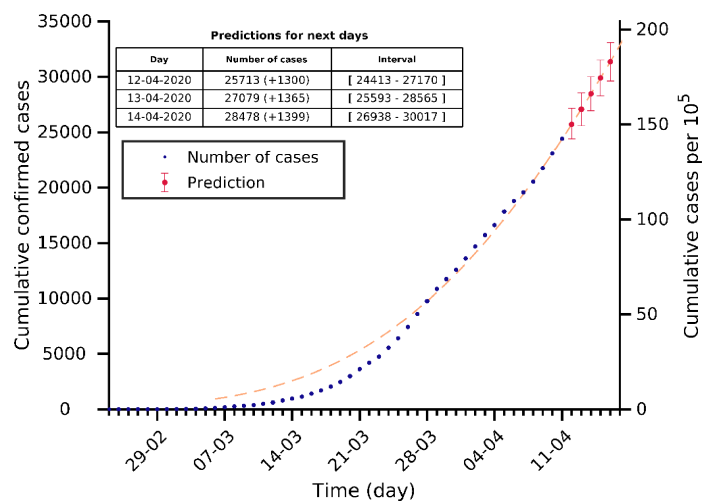
Belgium 11-04-2020. Population: 11.6M. Current cumulated incidence: 242/10⁵



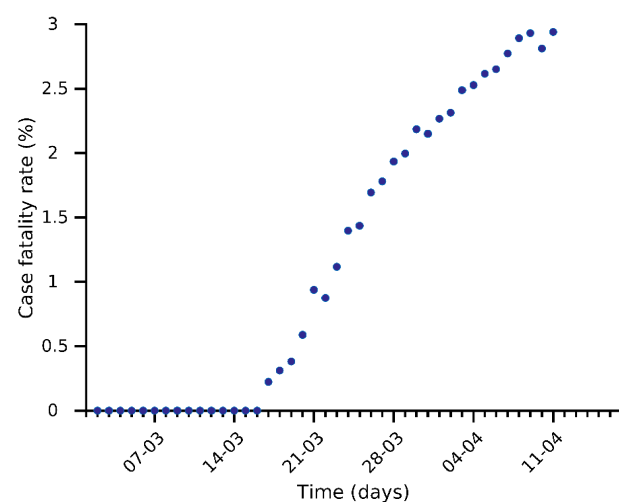
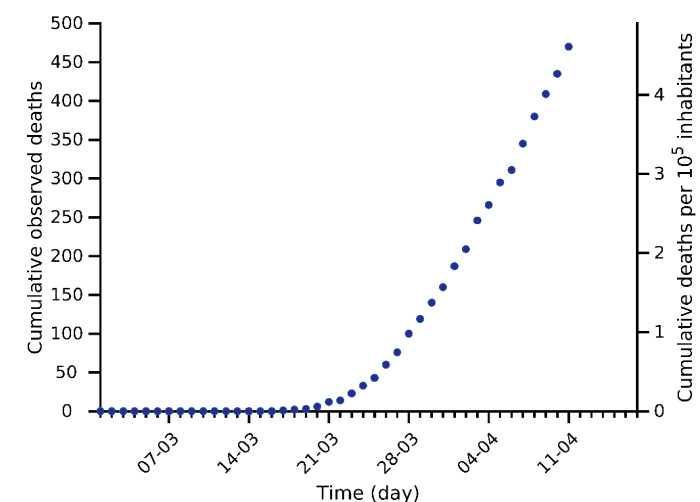
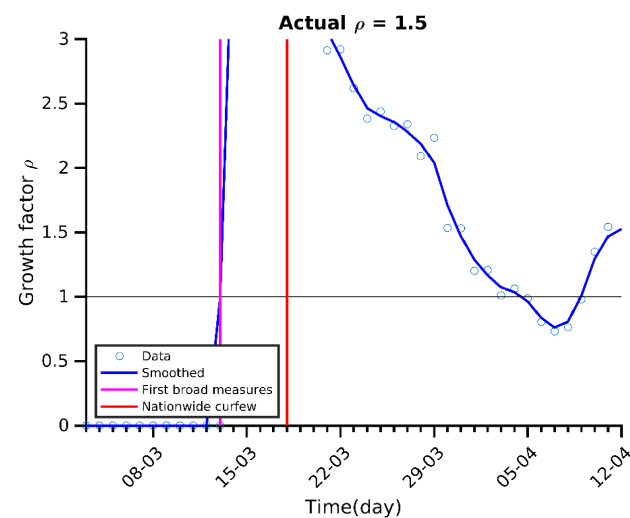
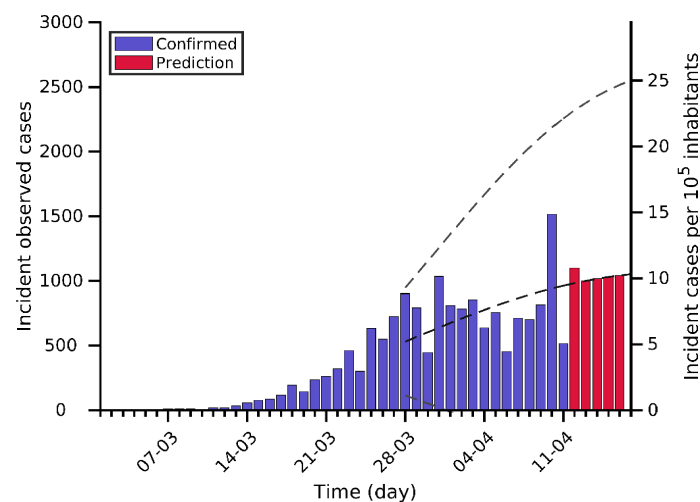
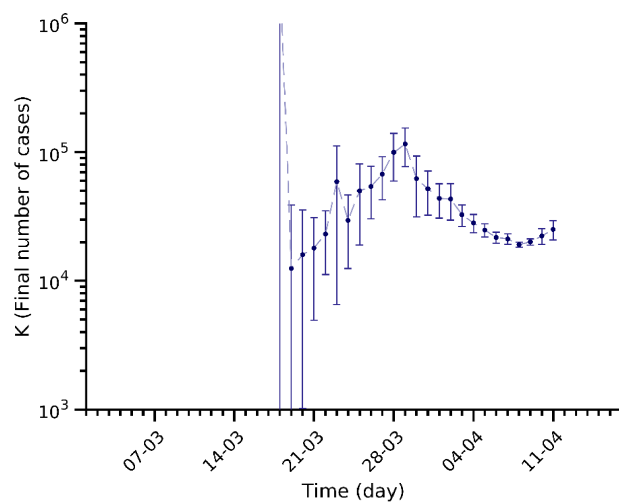
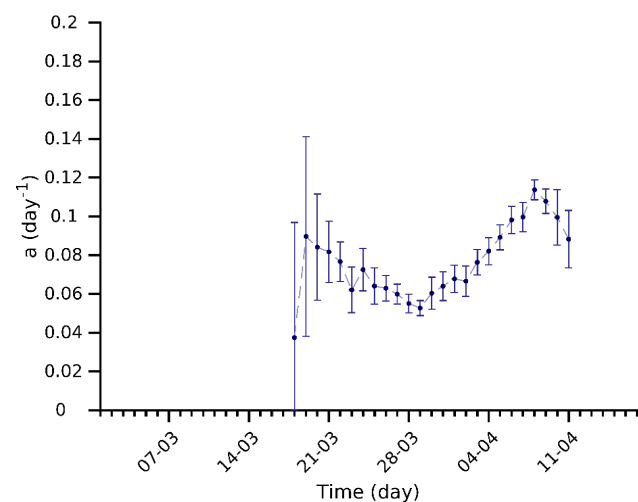
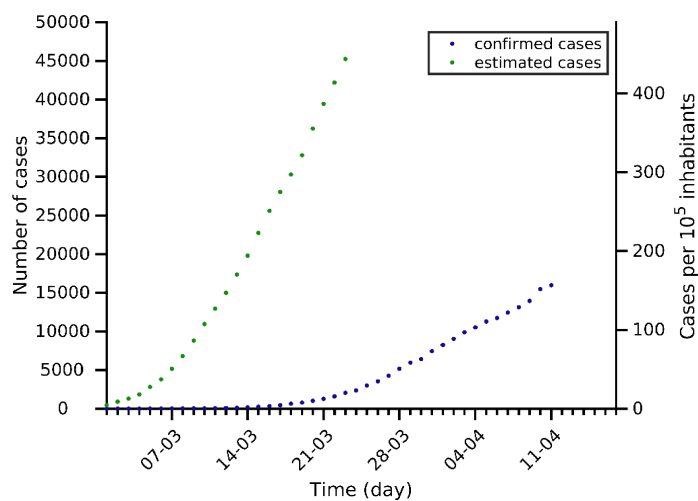
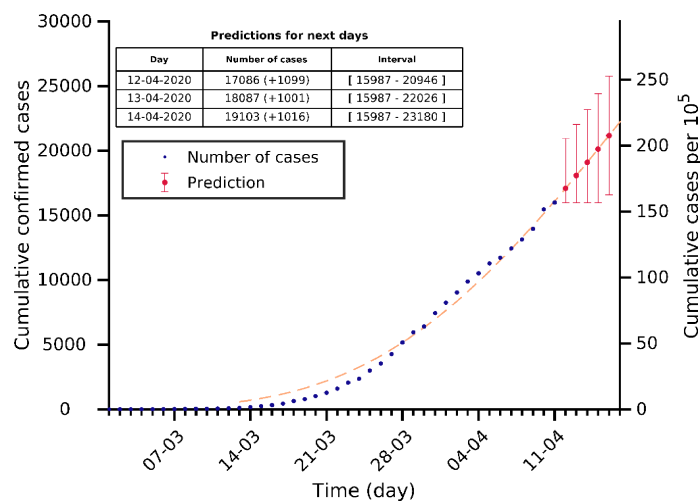
Switzerland 11-04-2020. Population: 8.7M. Current cumulated incidence: 287/10⁵



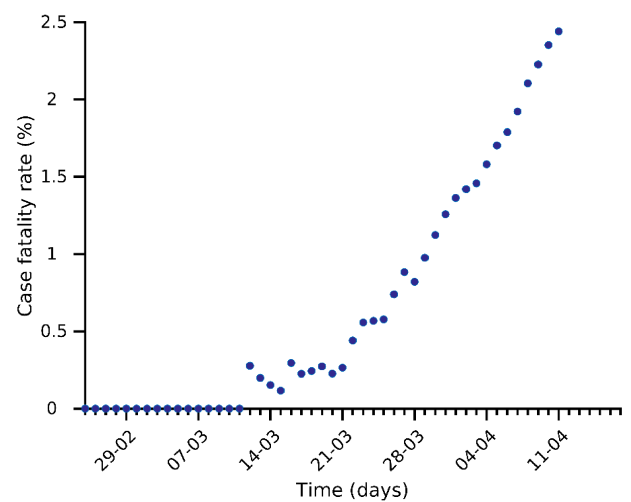
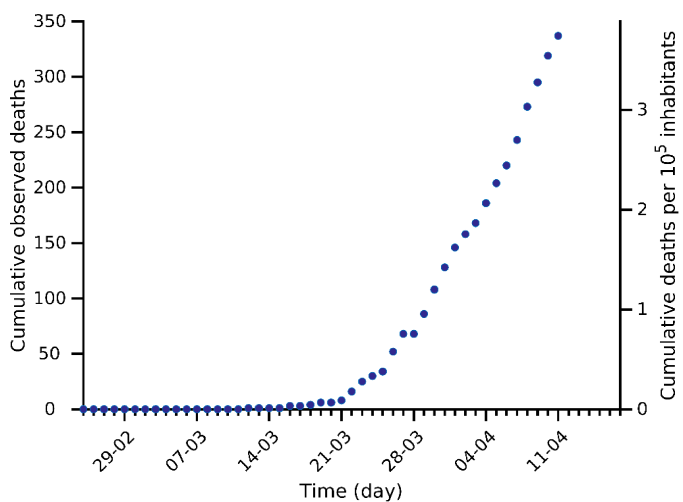
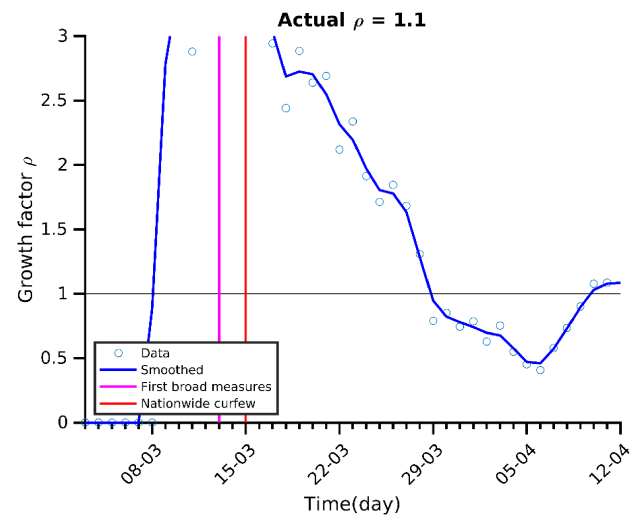
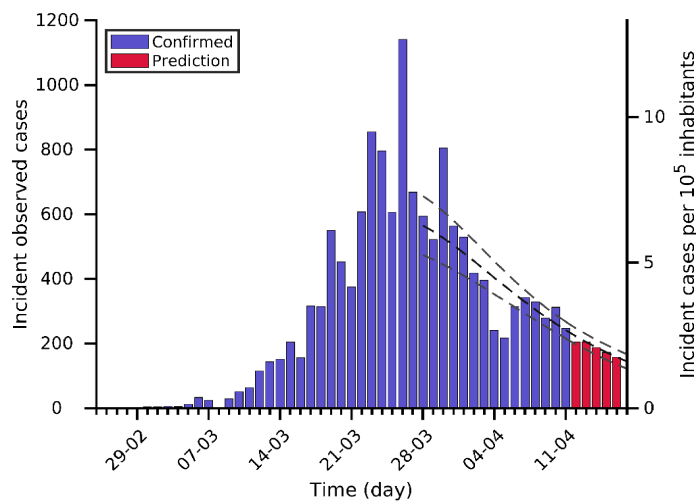
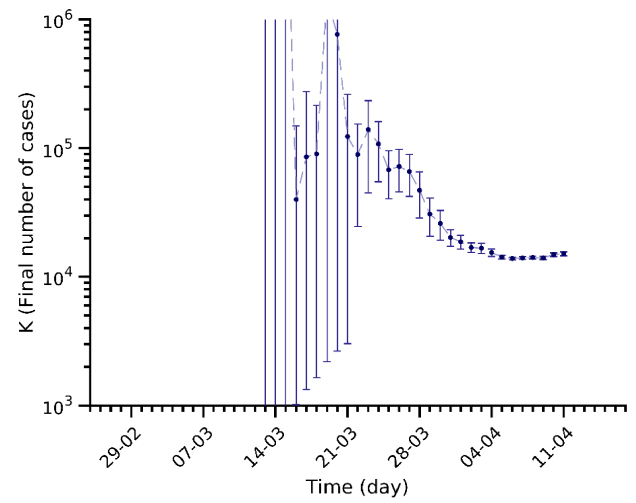
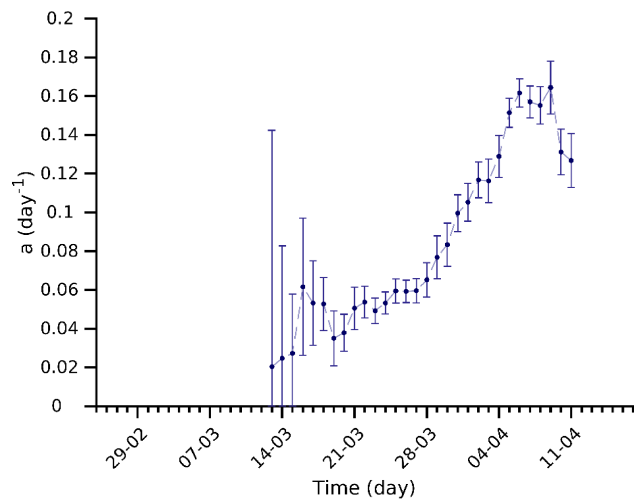
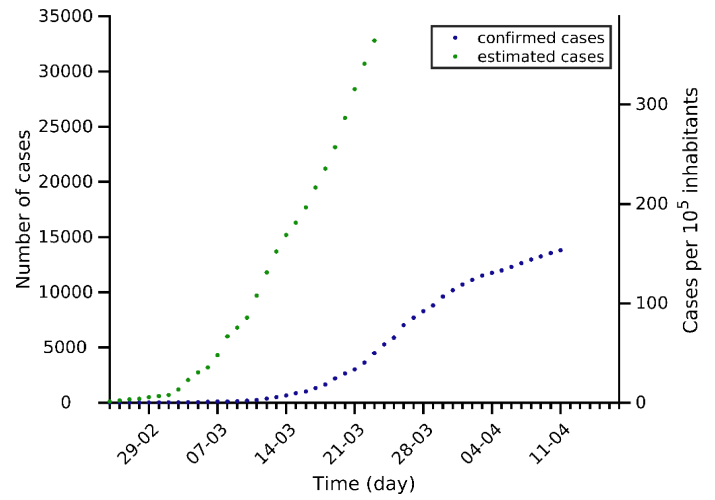
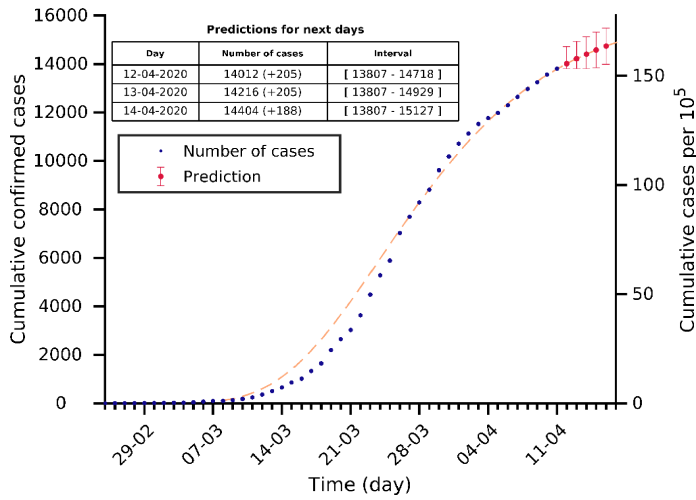
Netherlands 11-04-2020. Population: 17.1M. Current cumulated incidence: 142/10⁵



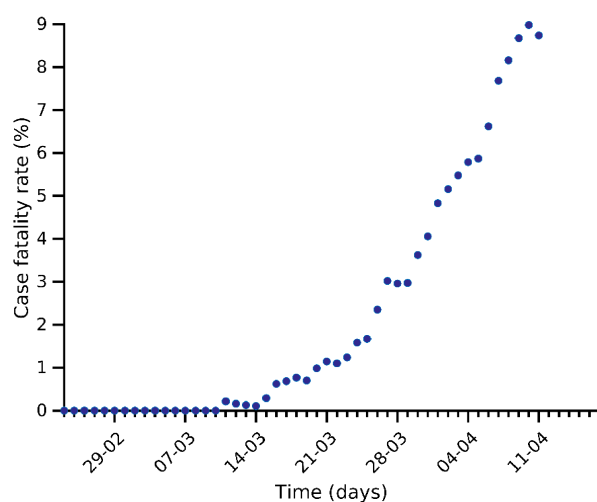
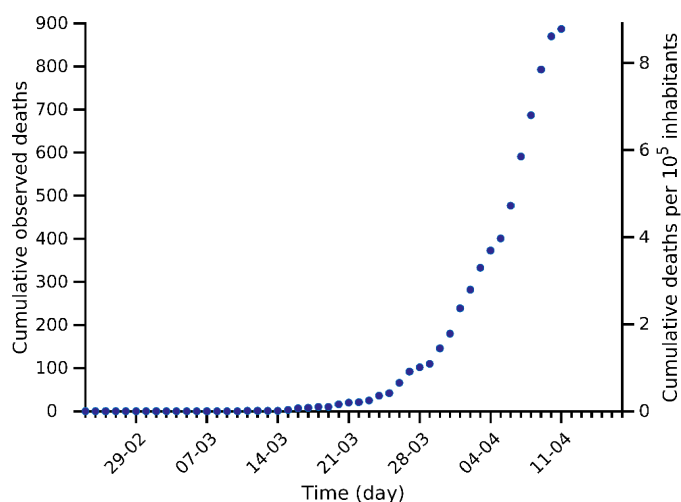
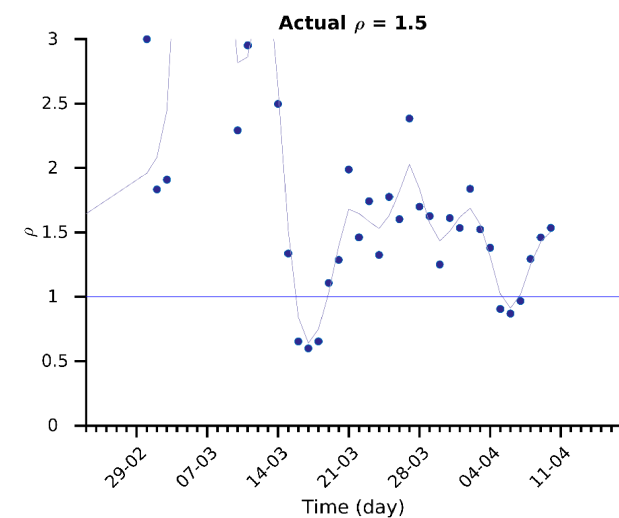
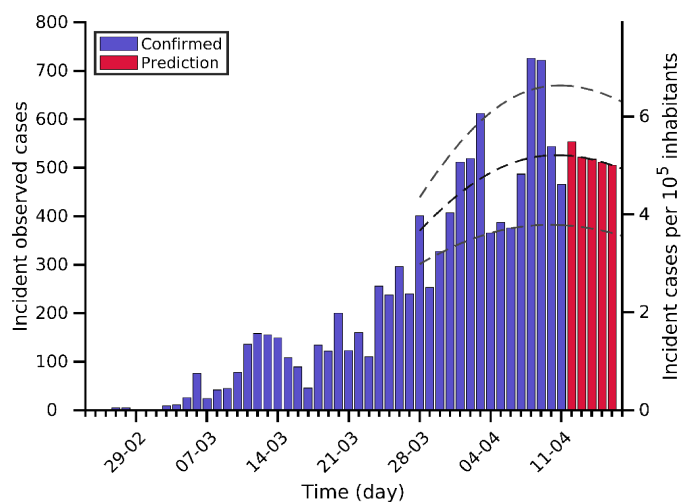
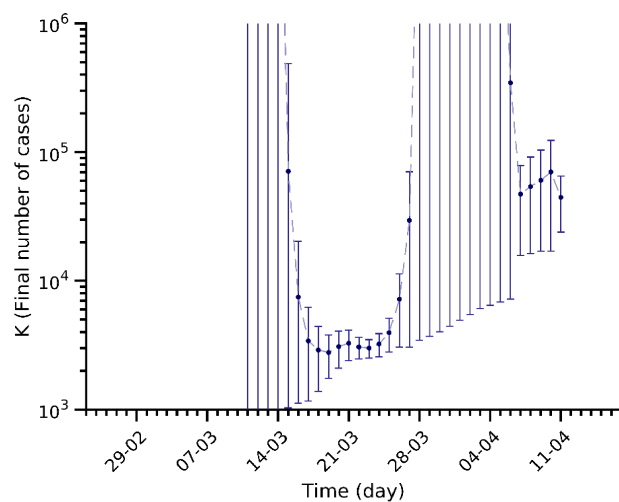
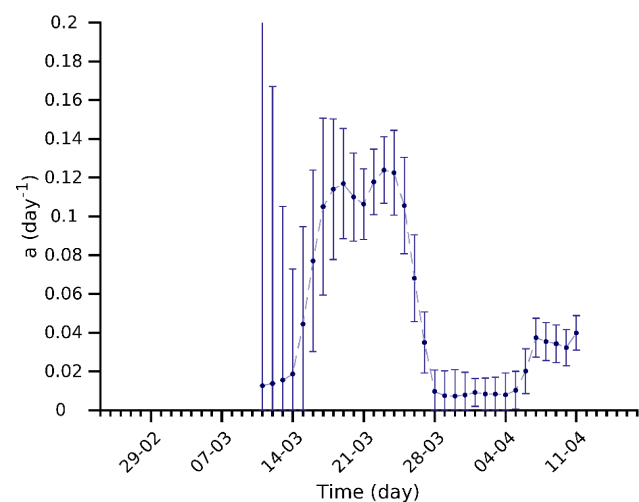
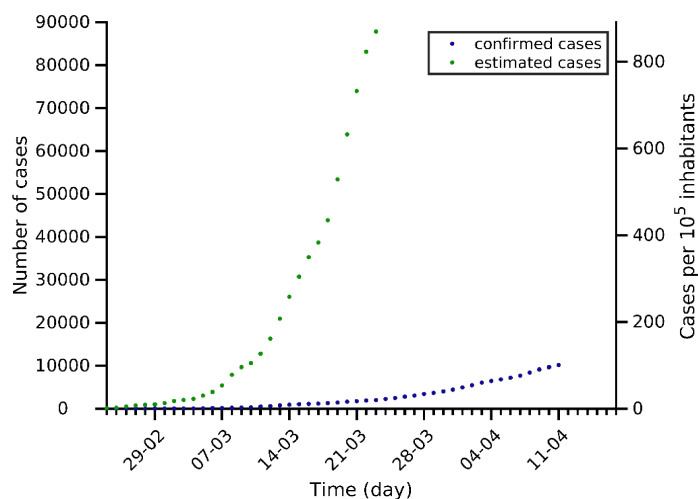
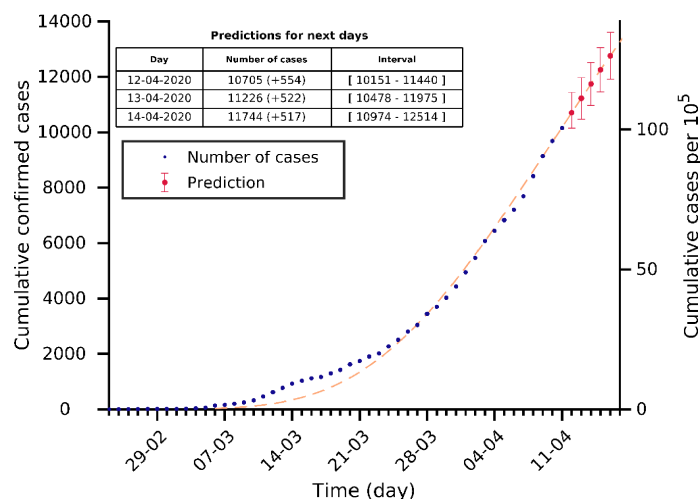
Portugal 11-04-2020. Population: 10.2M. Current cumulated incidence: 157/10⁵



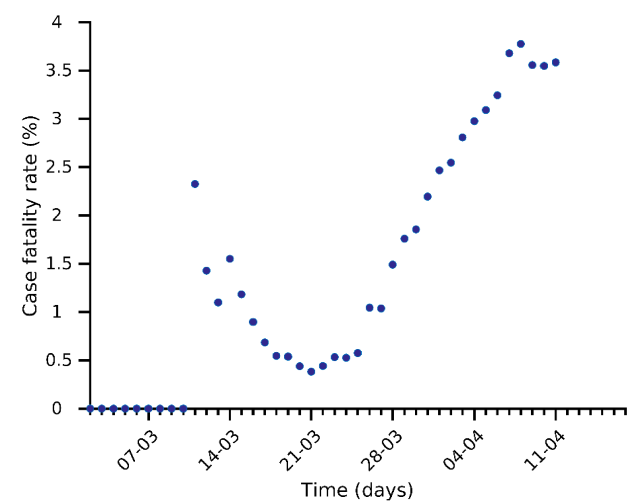
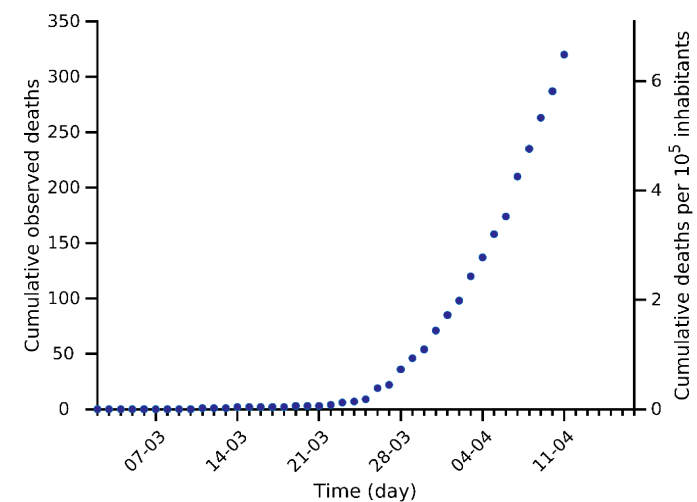
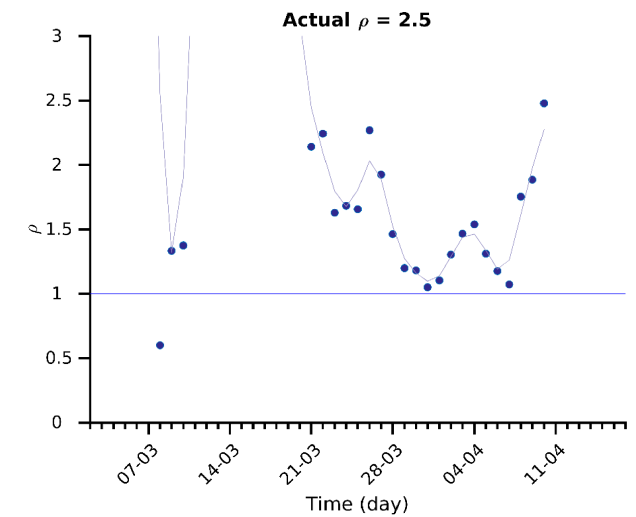
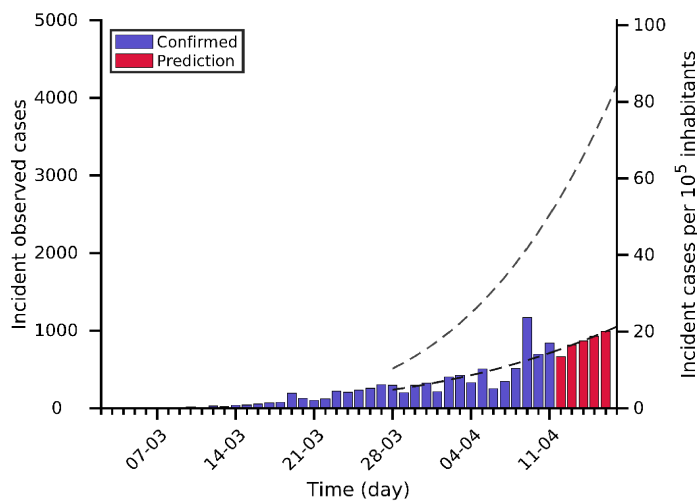
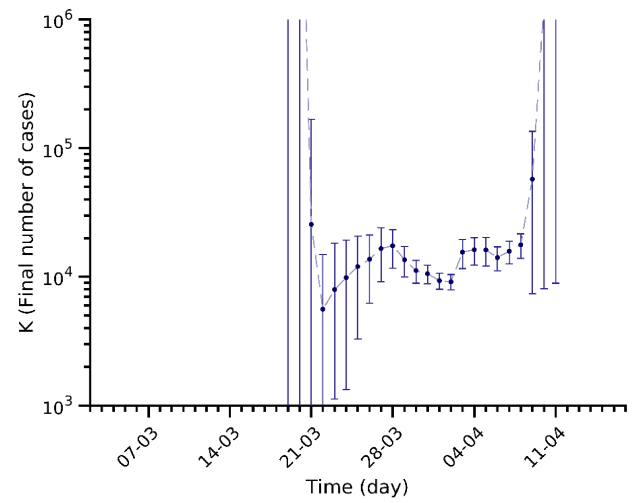
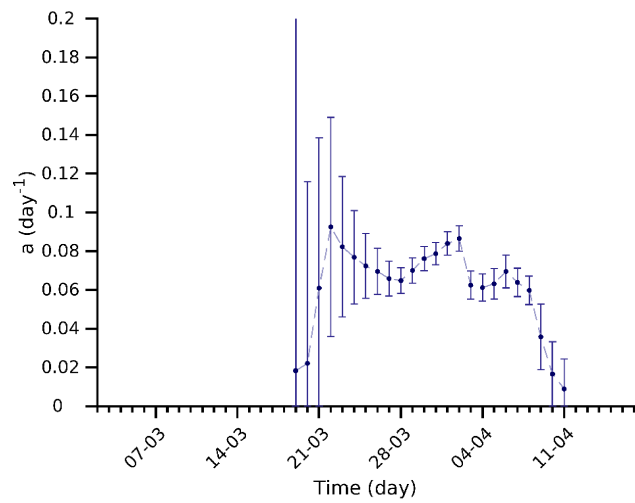
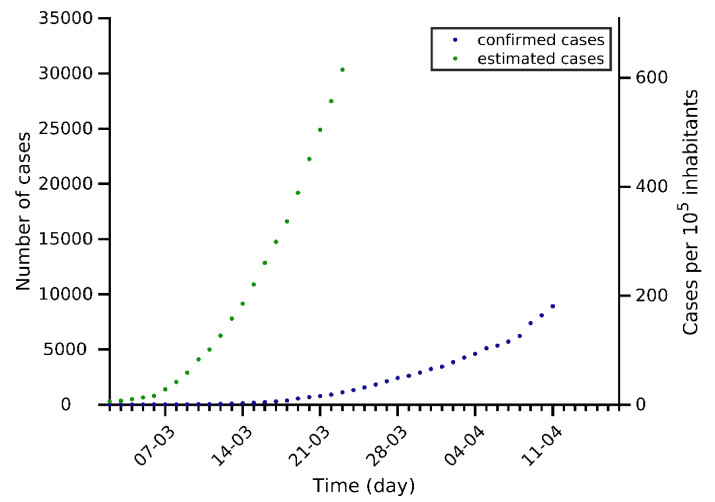
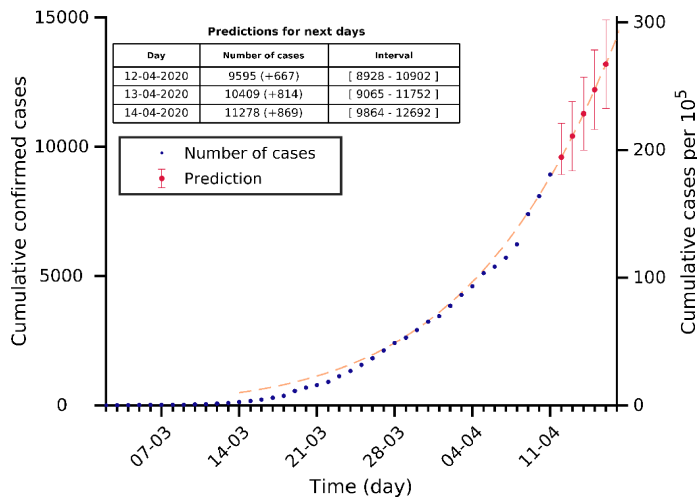
Austria 11-04-2020. Population: 9.0M. Current cumulated incidence: 153/10⁵



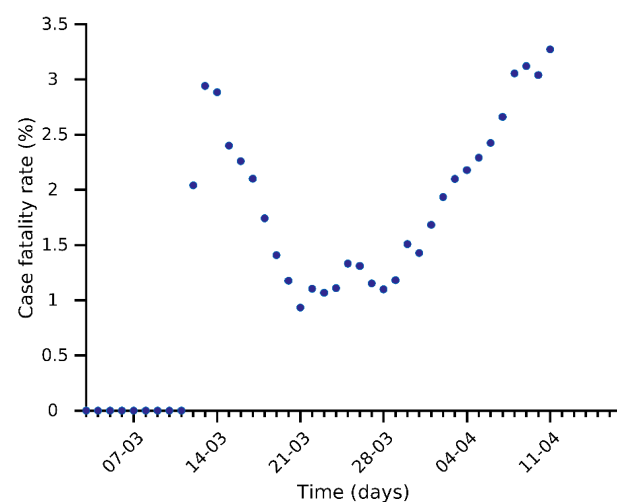
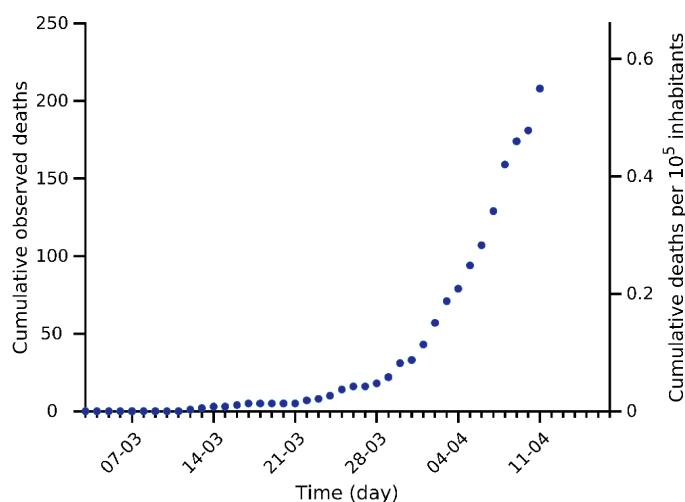
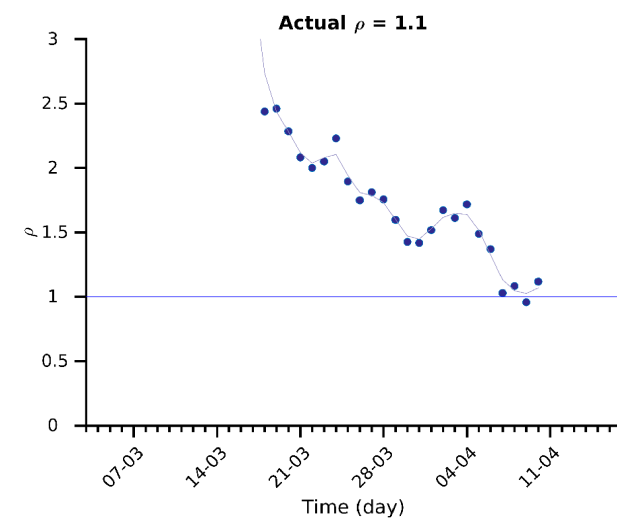
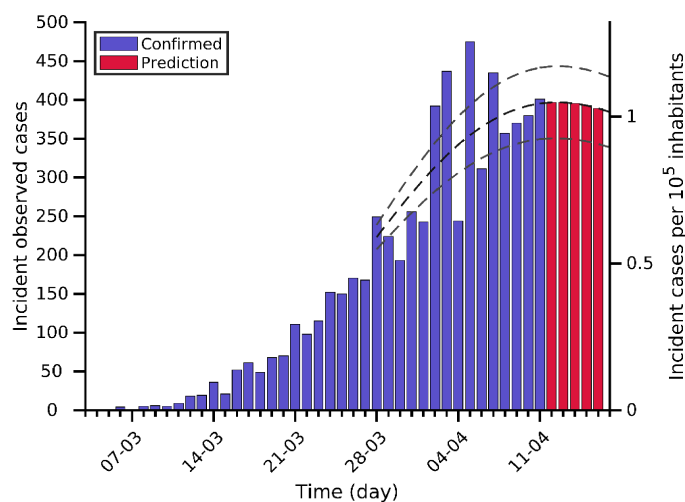
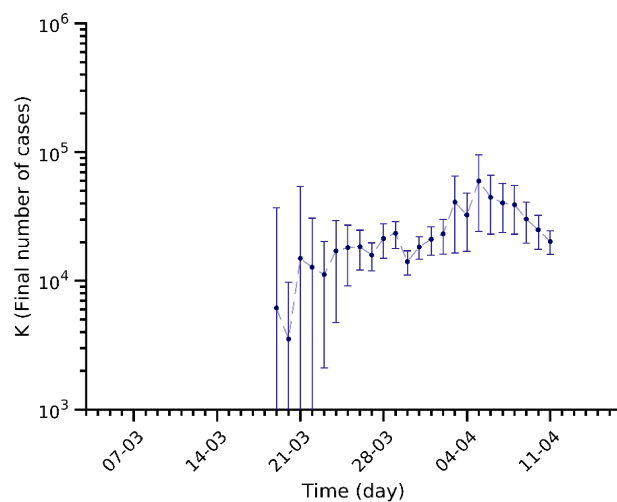
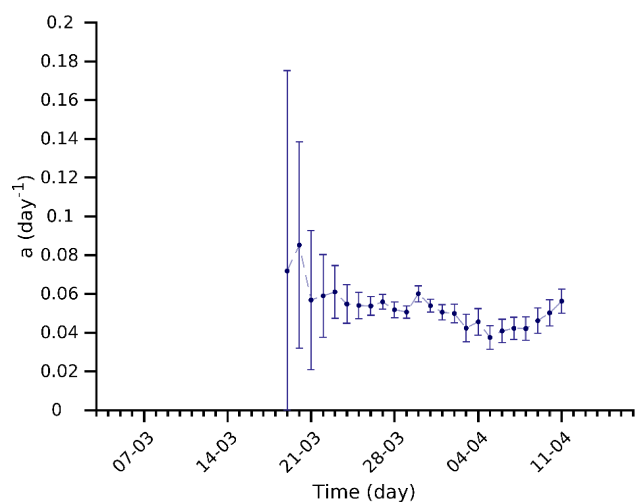
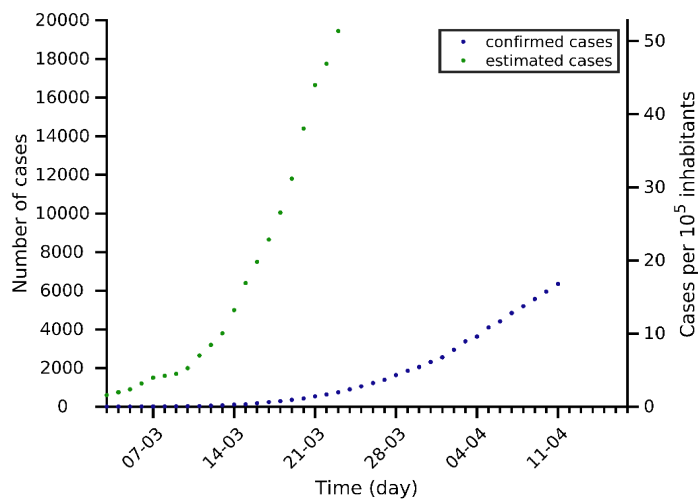
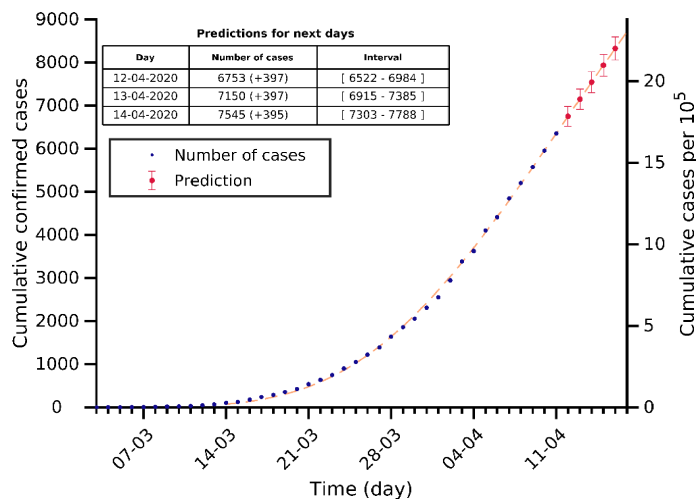
Sweden 11-04-2020. Population: 10.1M. Current cumulated incidence: 101/10⁵



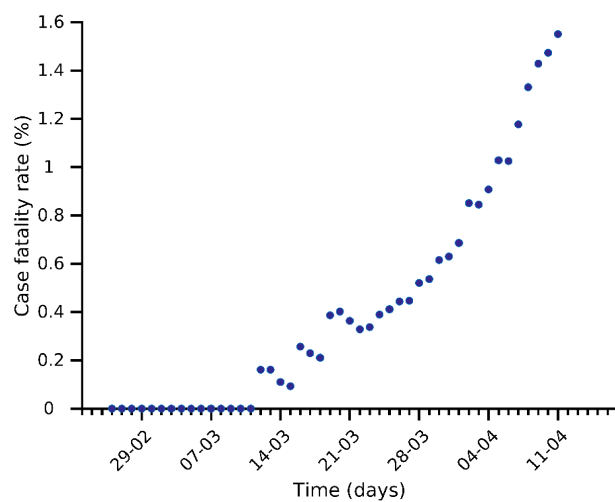
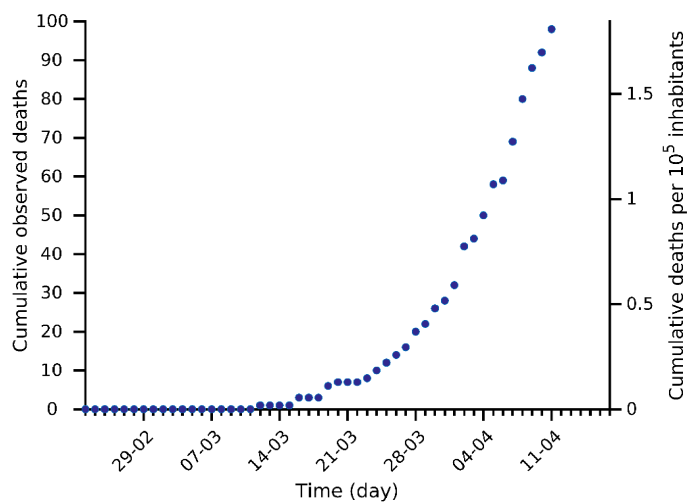
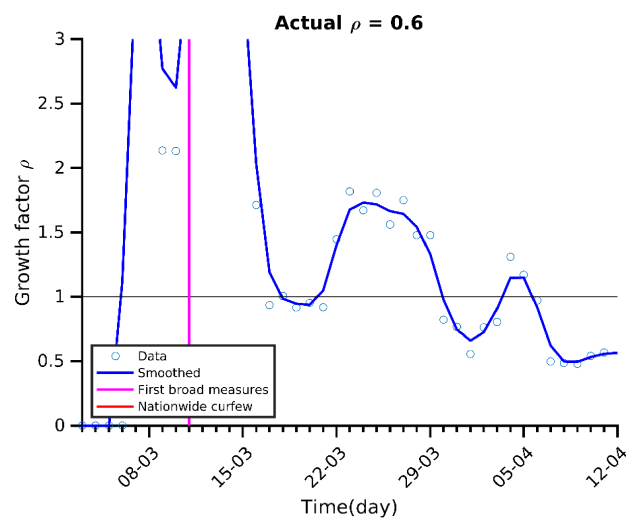
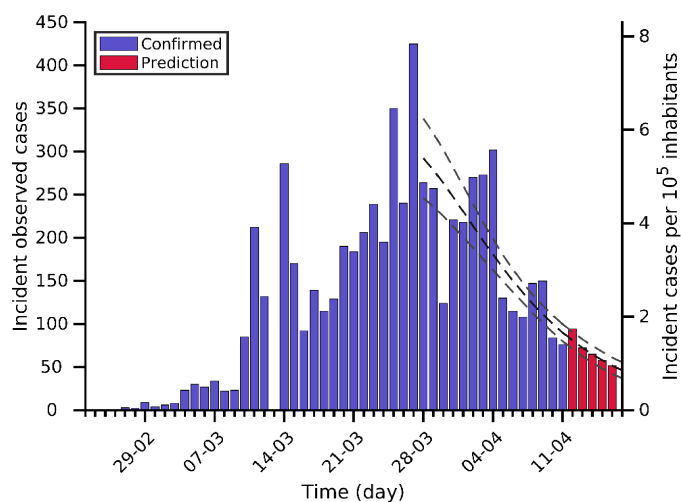
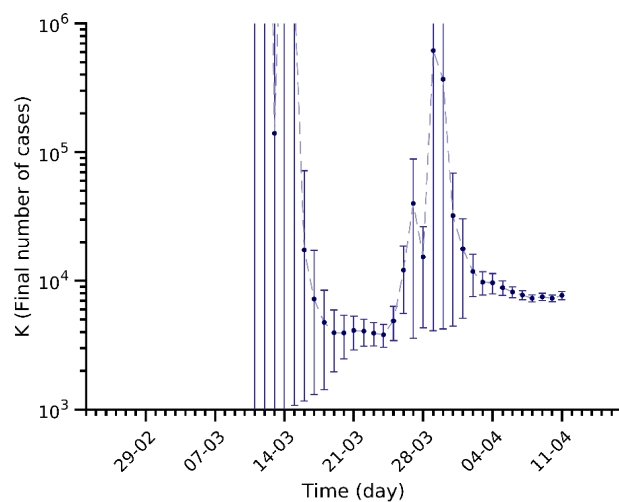
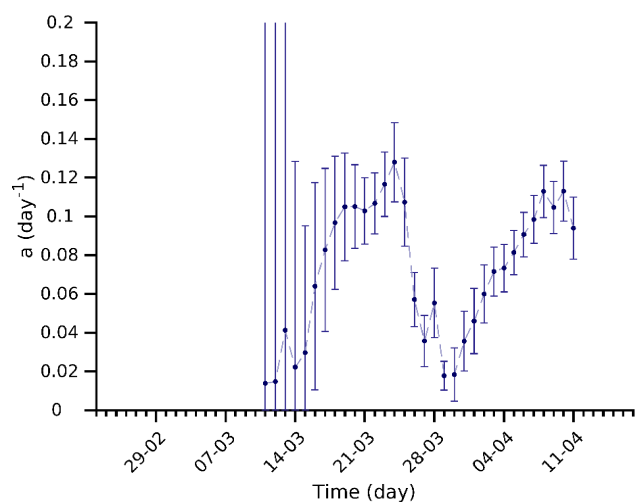
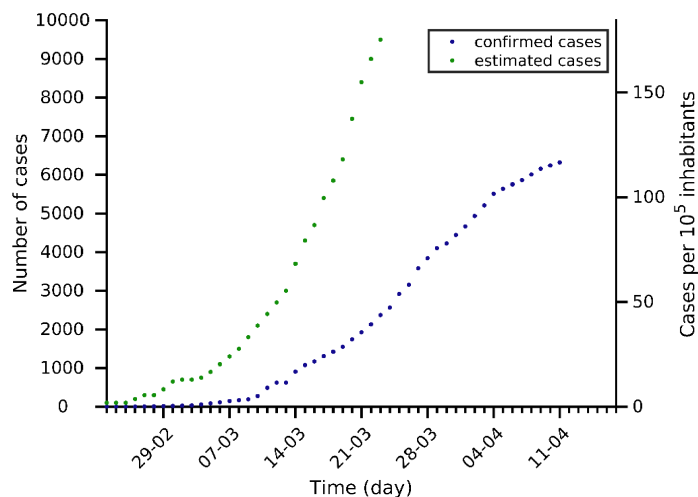
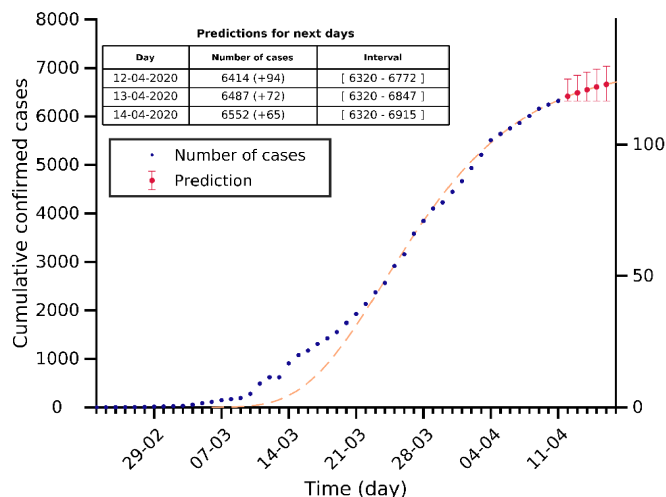
Ireland 11-04-2020. Population: 4.9M. Current cumulated incidence: 181/10⁵



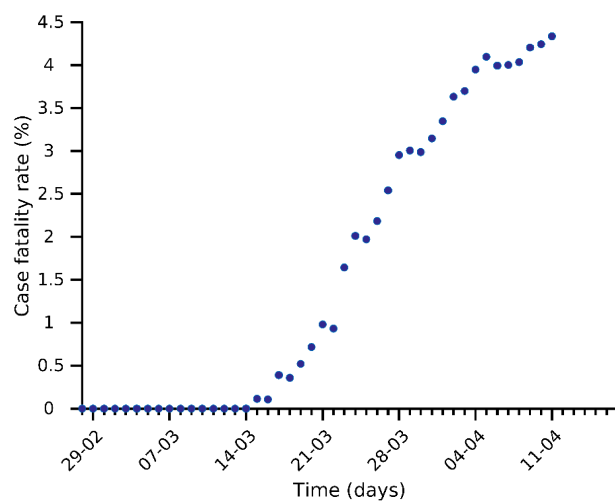
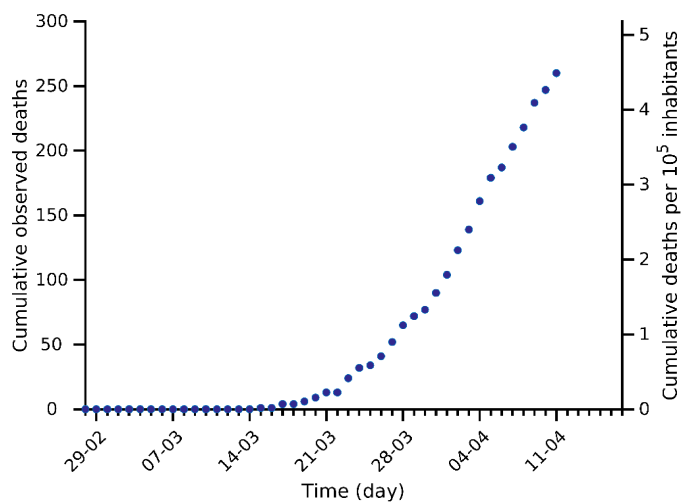
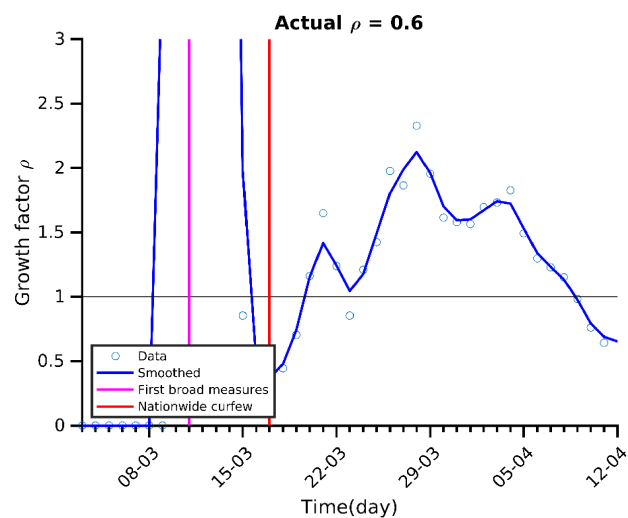
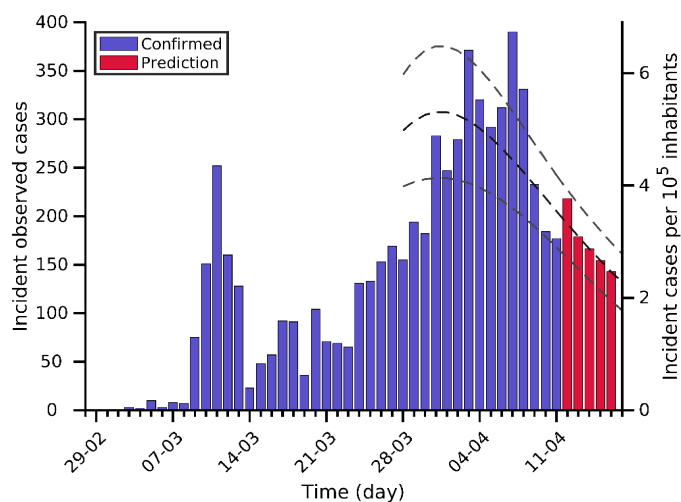
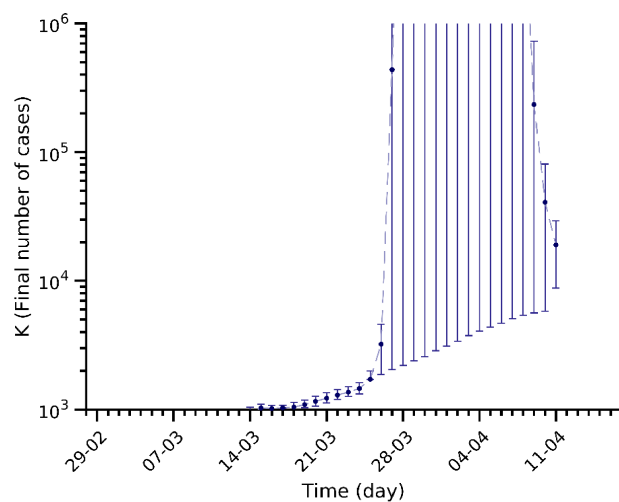
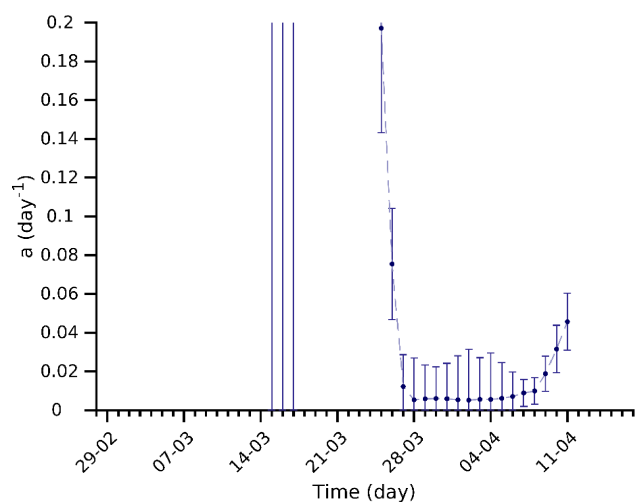
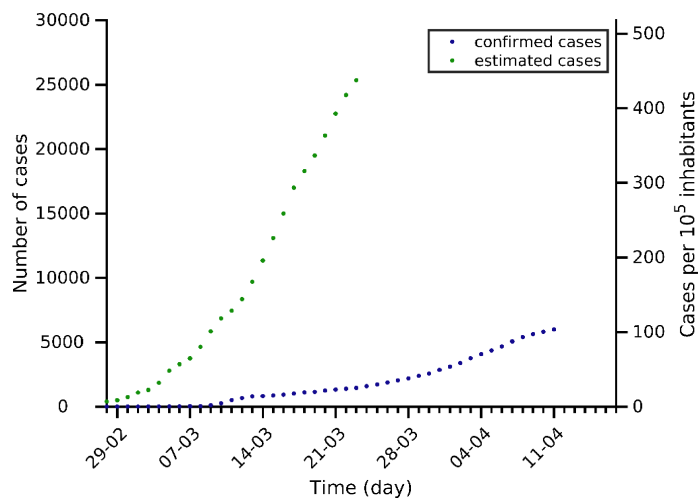
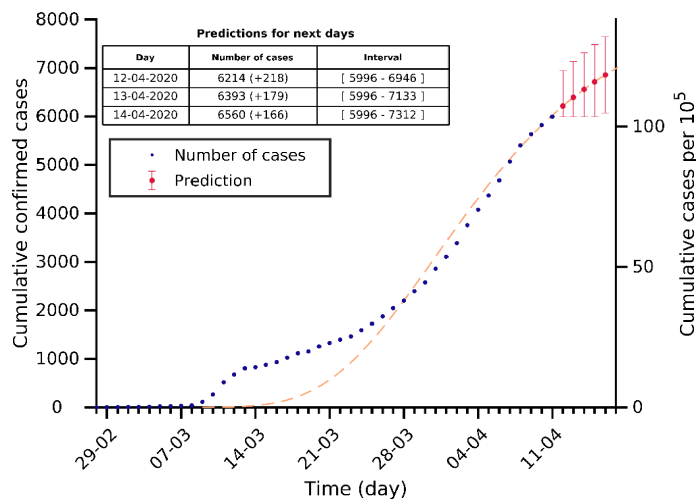
Poland 11-04-2020. Population: 37.8M. Current cumulated incidence: 17/10⁵



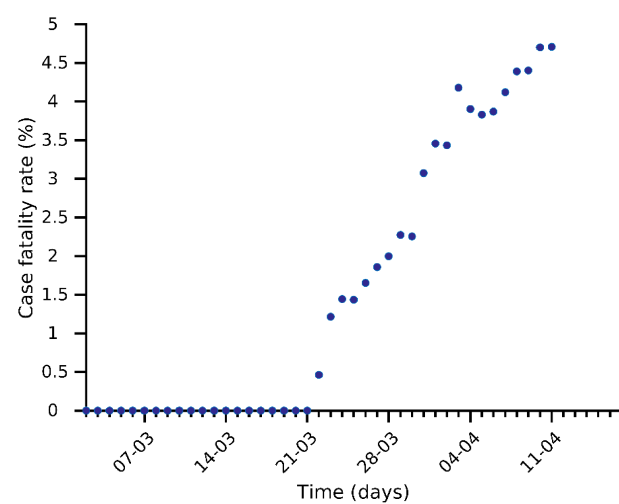
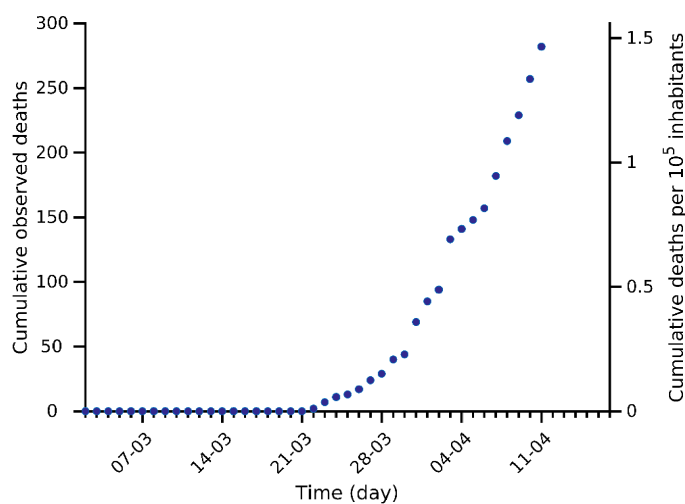
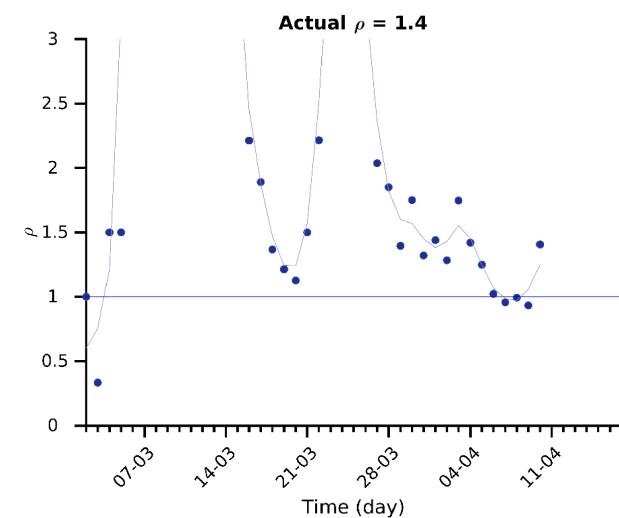
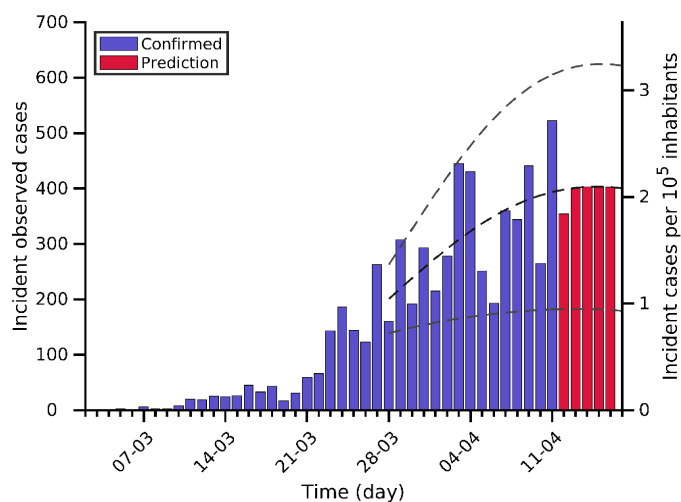
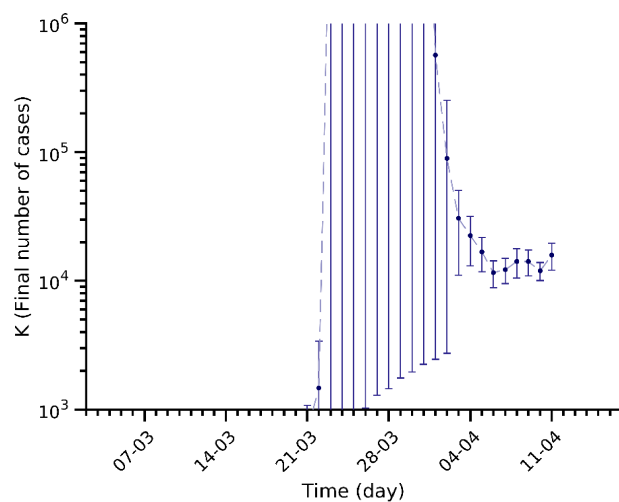
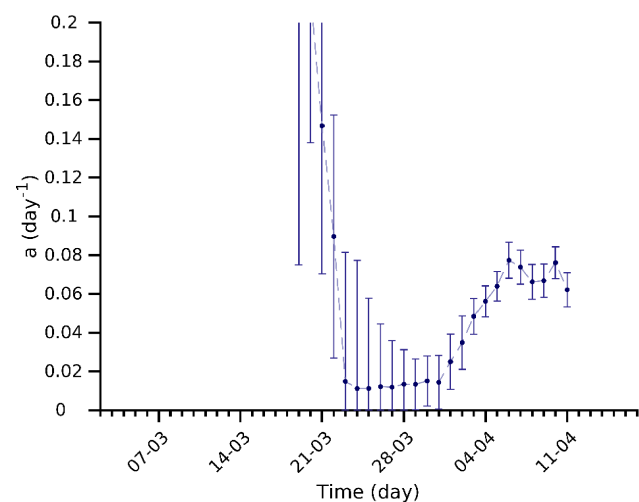
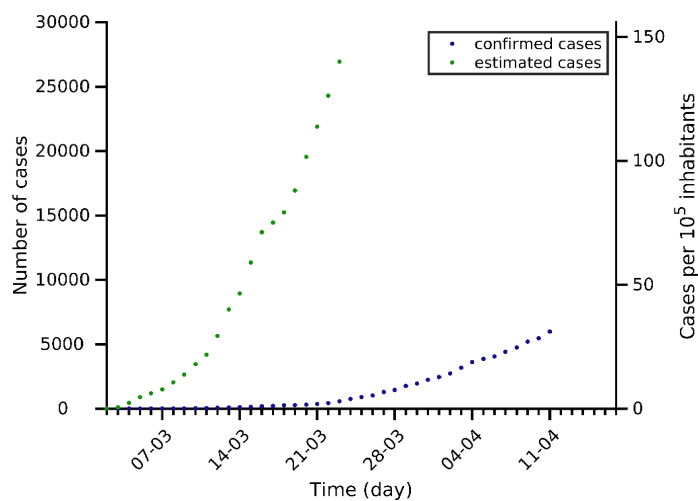
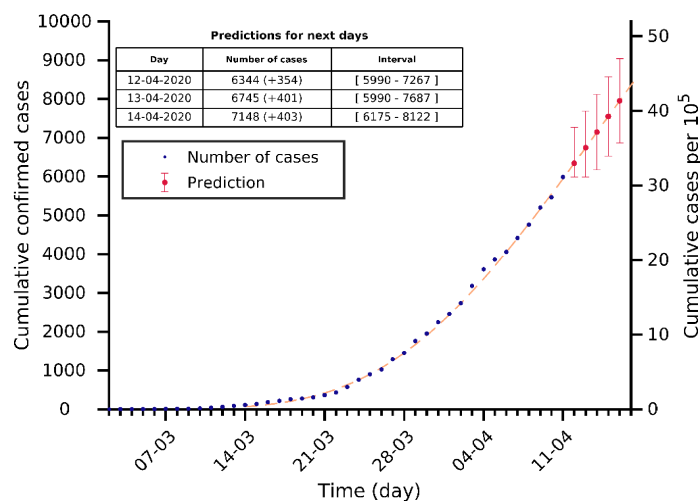
Norway 11-04-2020. Population: 5.4M. Current cumulated incidence: 117/10⁵



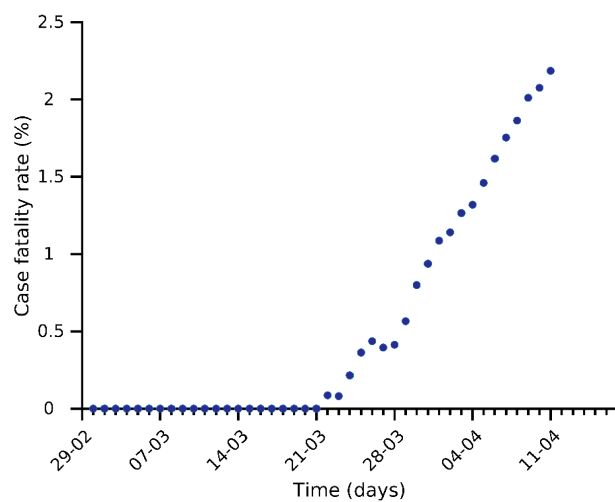
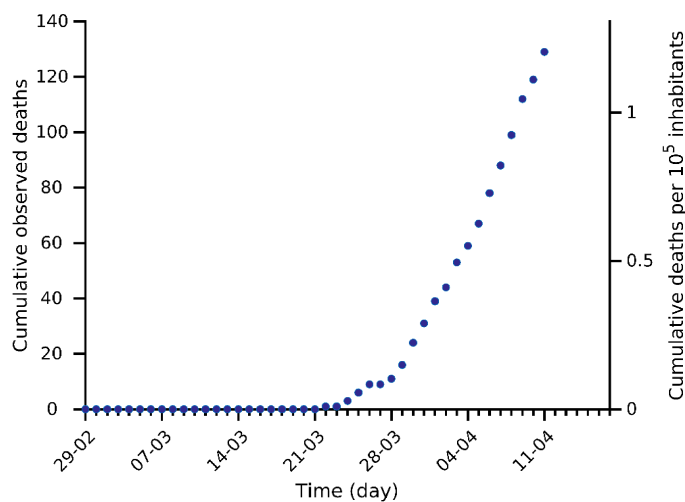
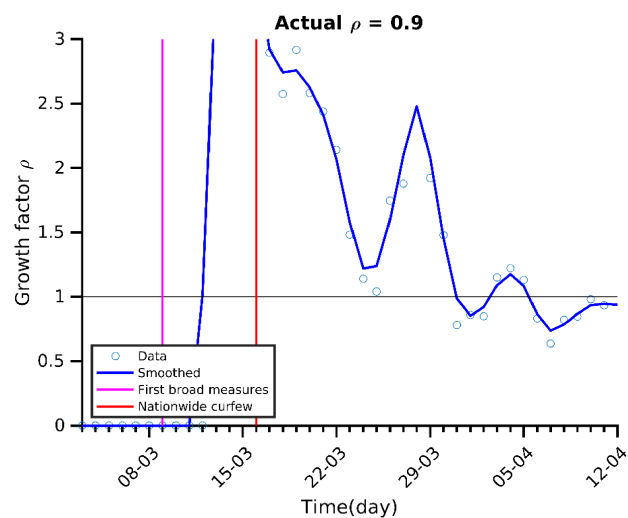
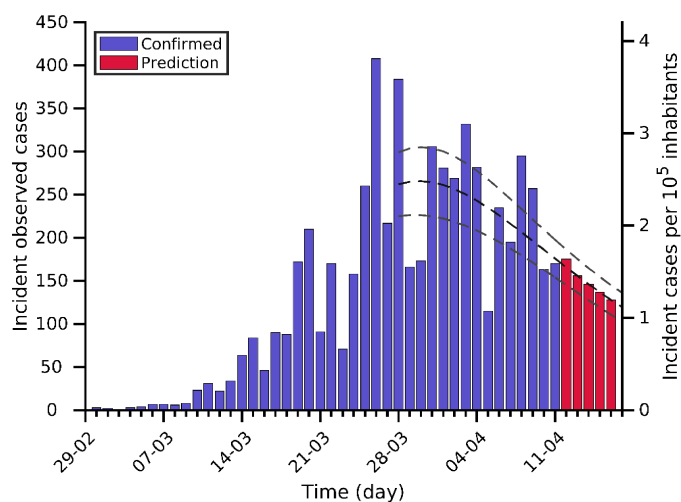
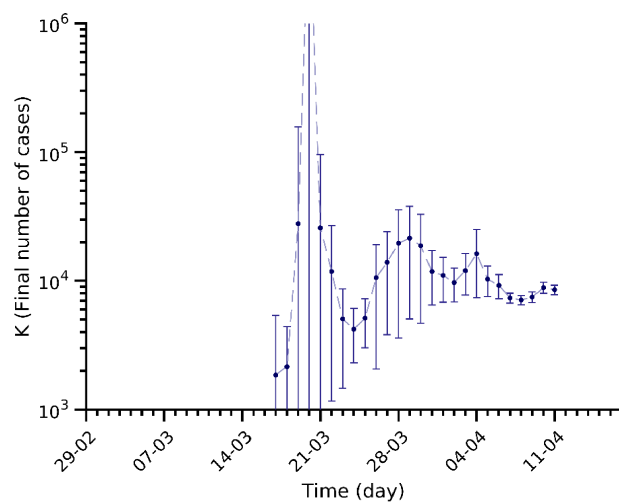
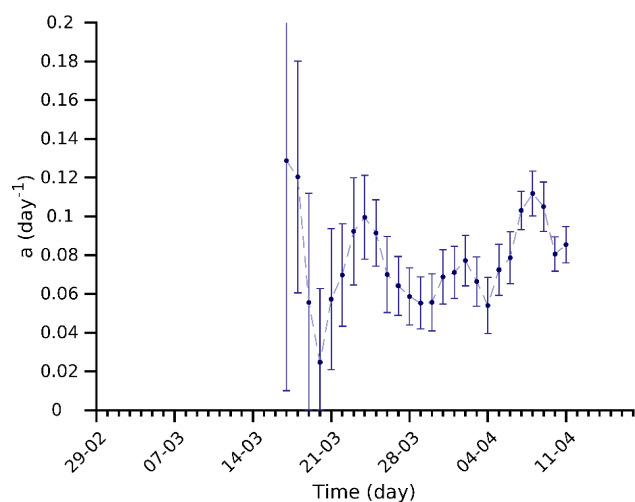
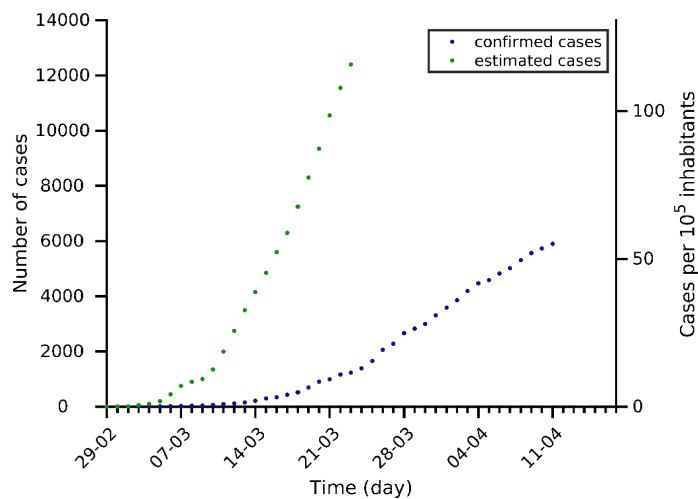
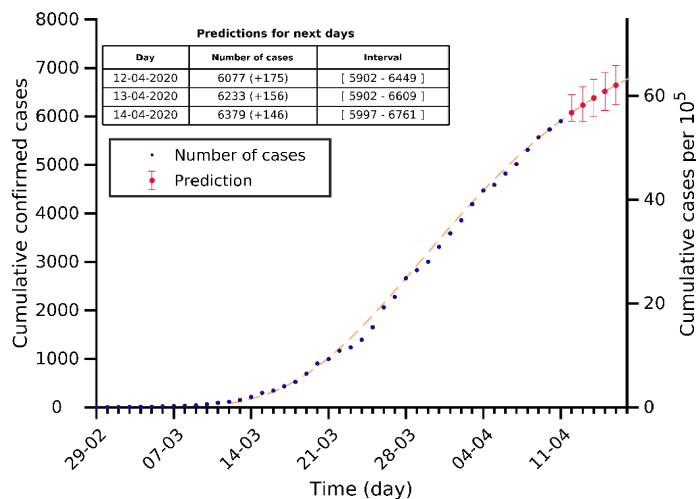
Denmark 11-04-2020. Population: 5.8M. Current cumulated incidence: 104/10⁵



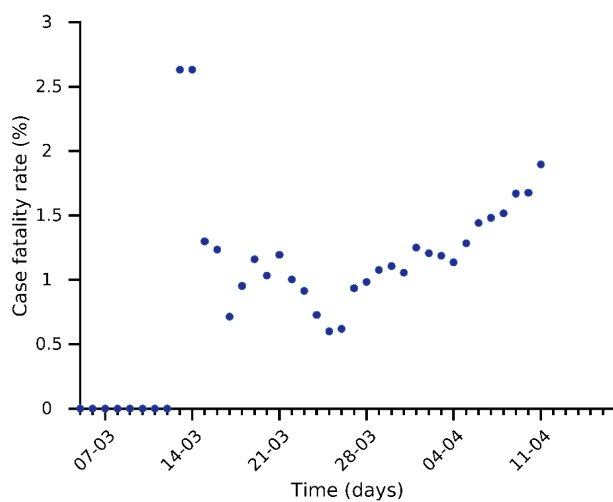
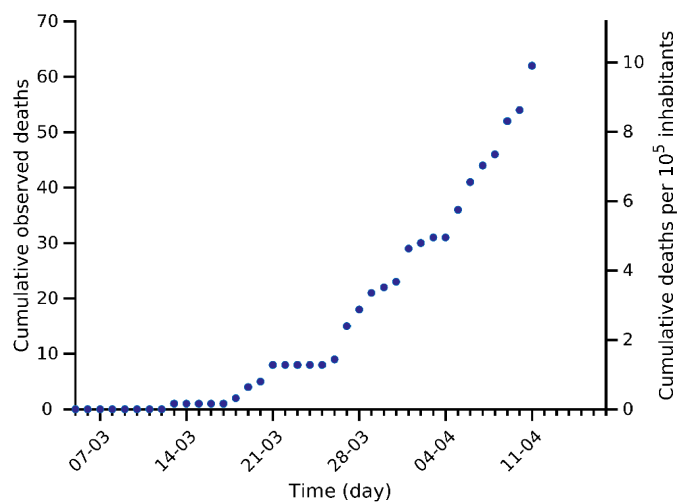
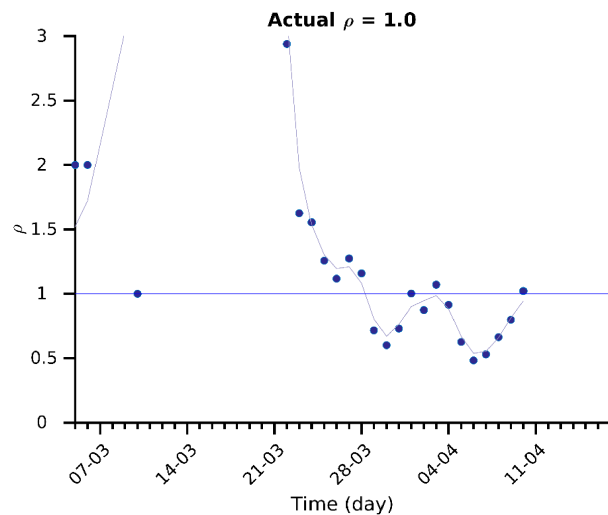
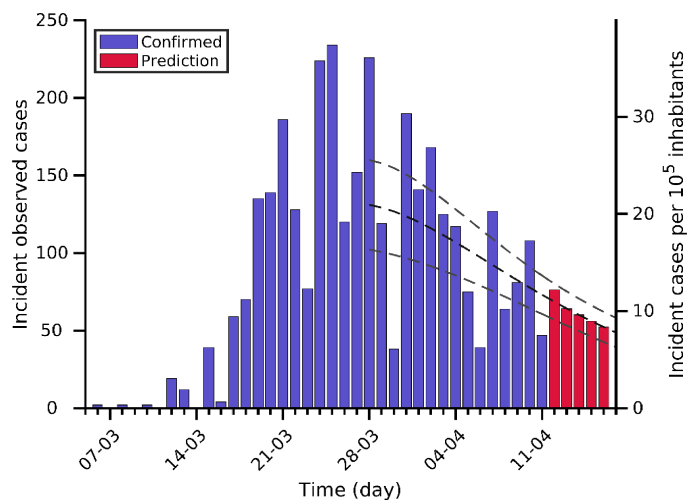
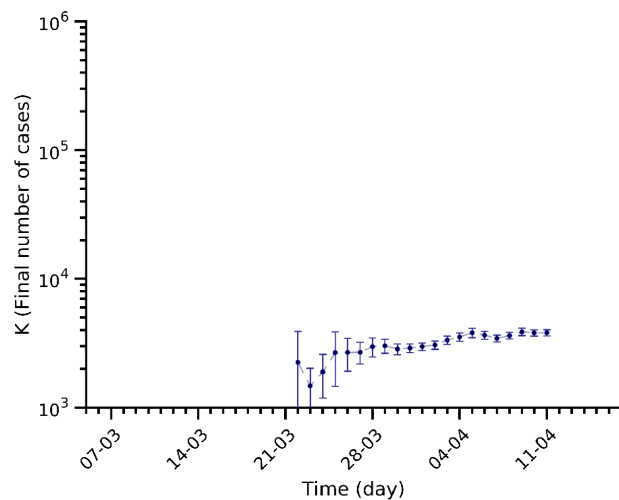
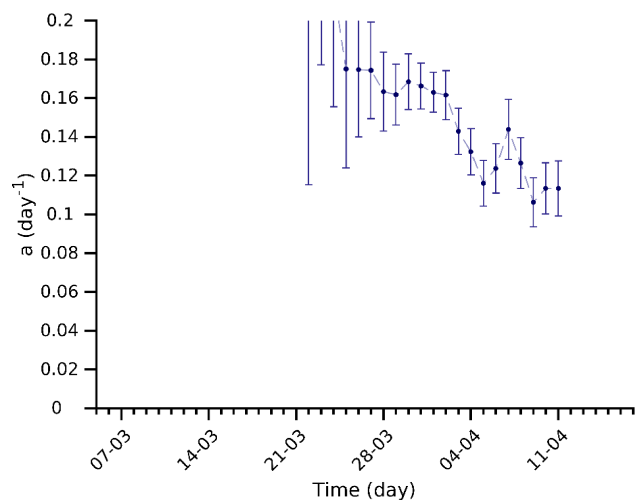
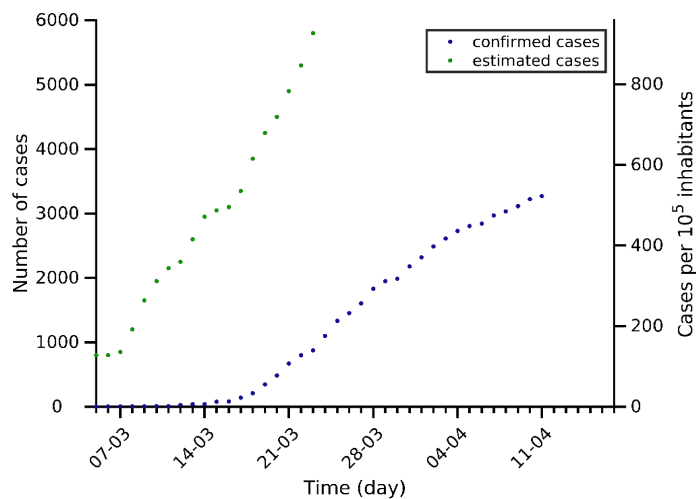
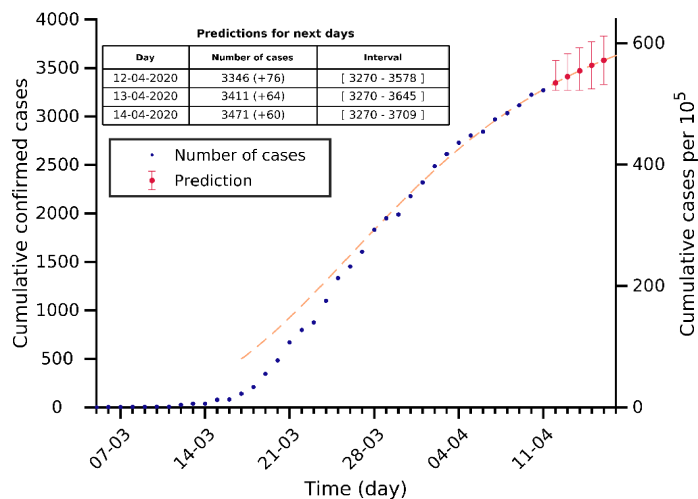
Romania 11-04-2020. Population: 19.2M. Current cumulated incidence: 31/10⁵



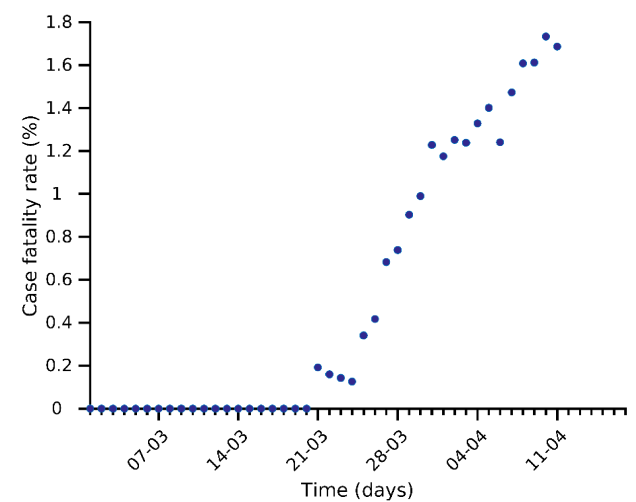
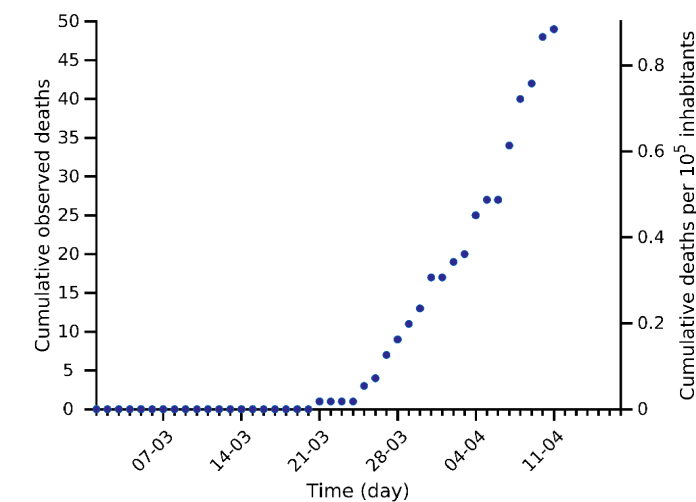
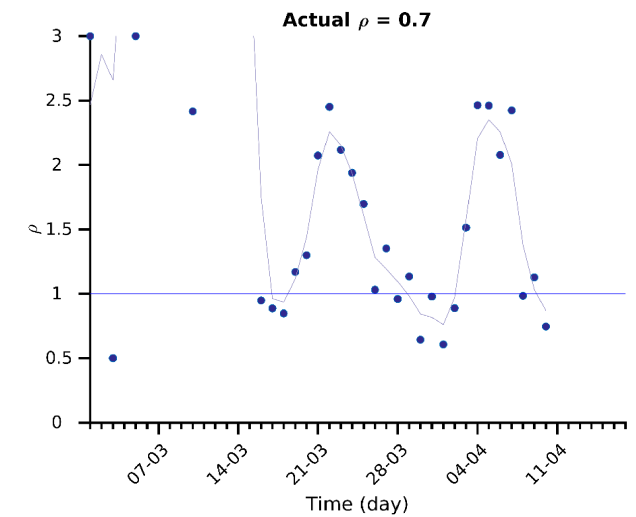
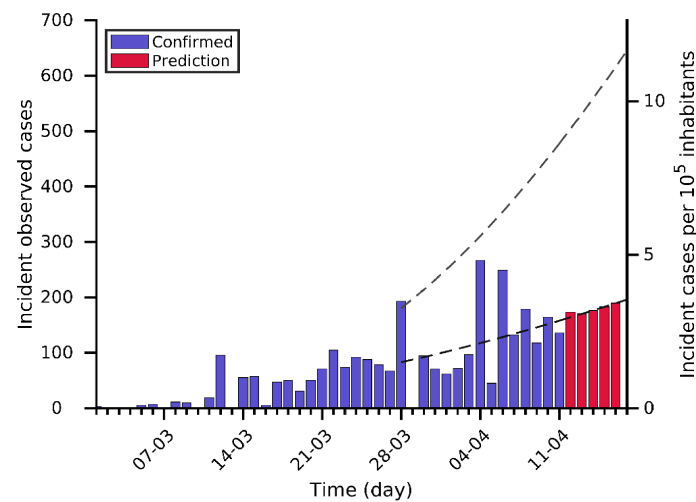
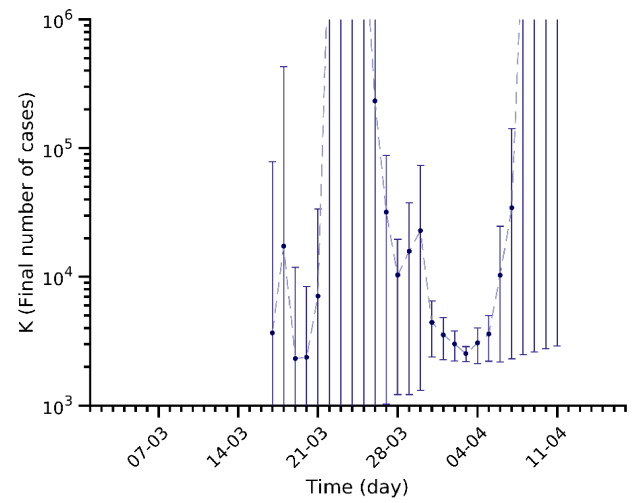
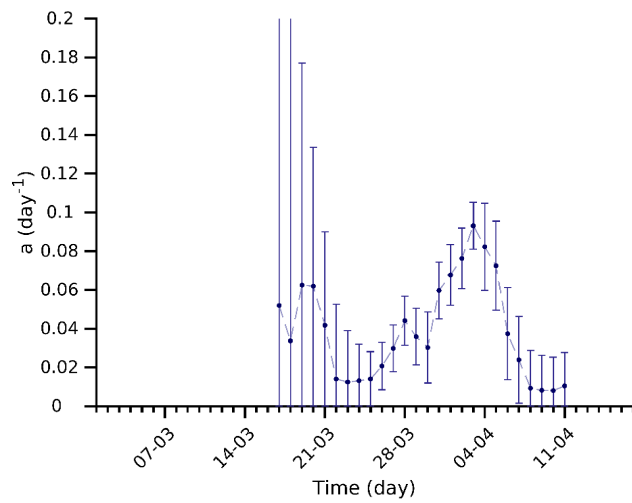
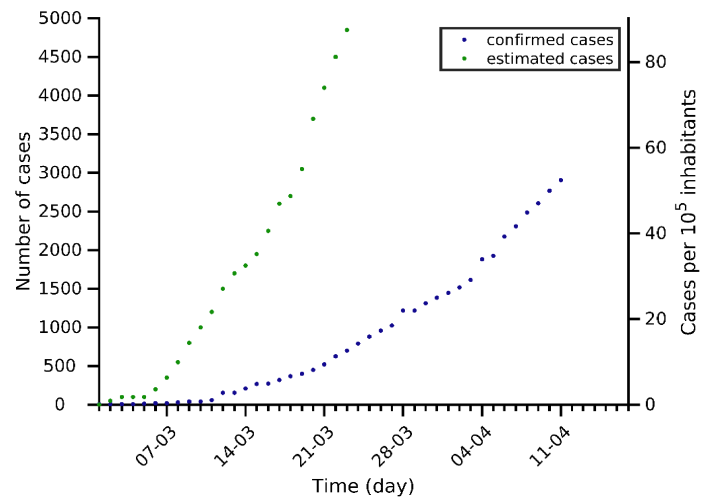
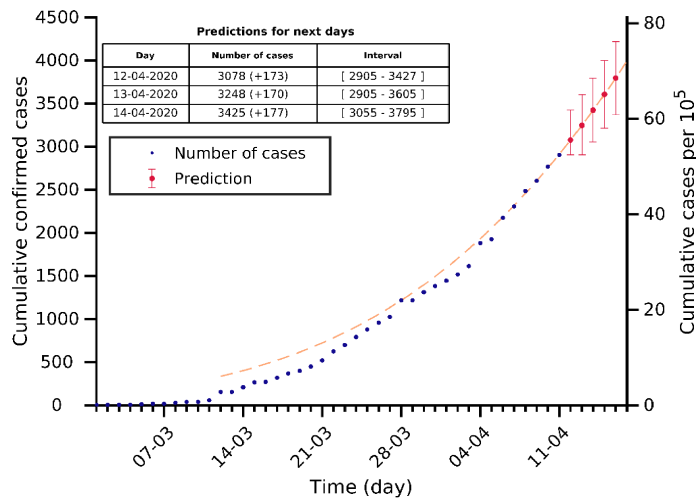
Czech Rep 11-04-2020. Population: 10.7M. Current cumulated incidence: 55/10⁵



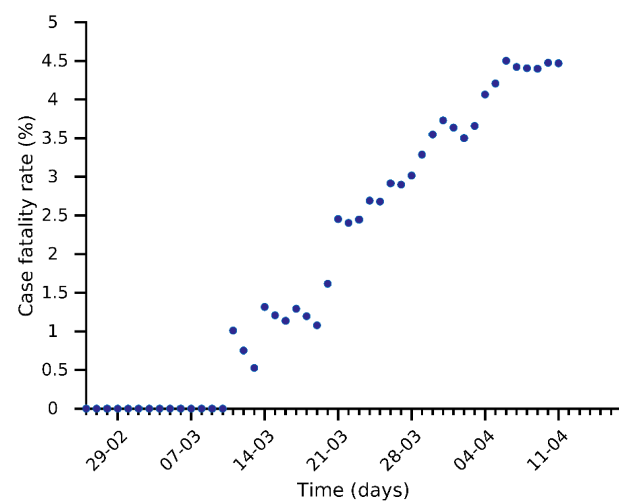
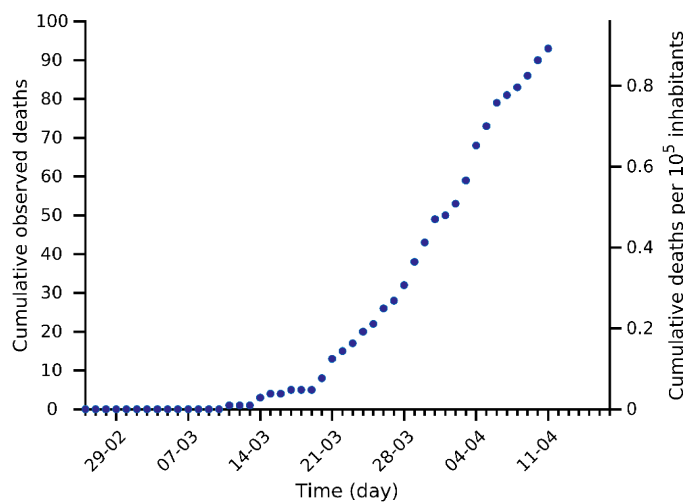
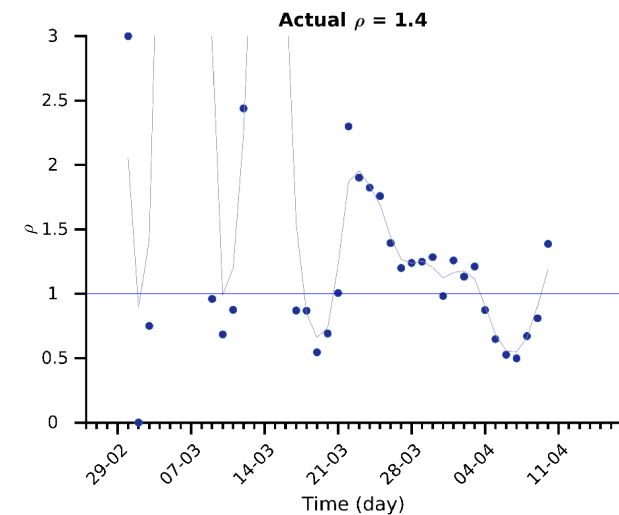
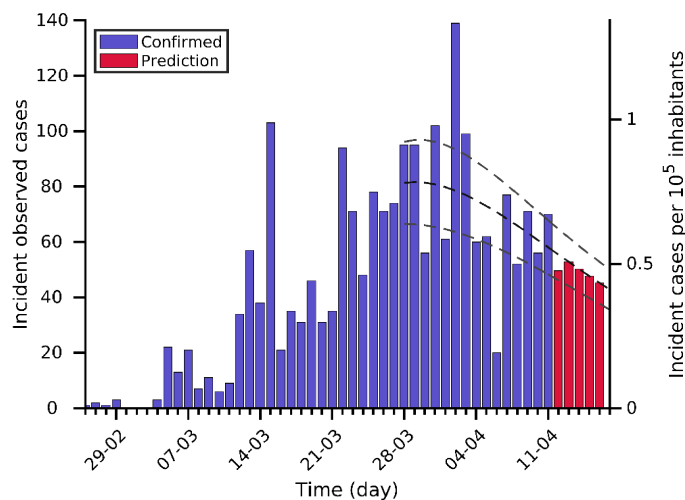
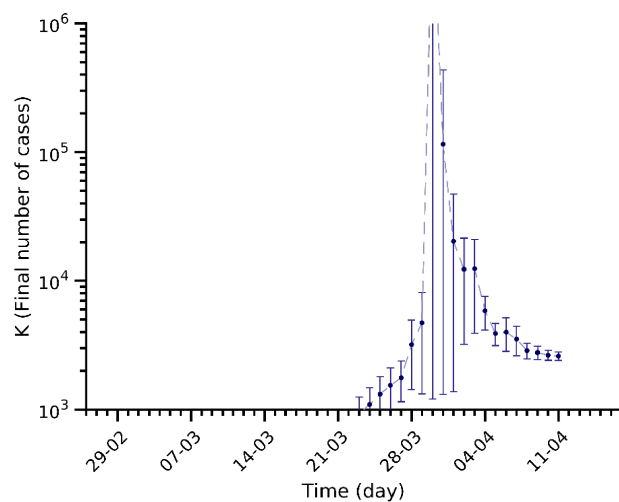
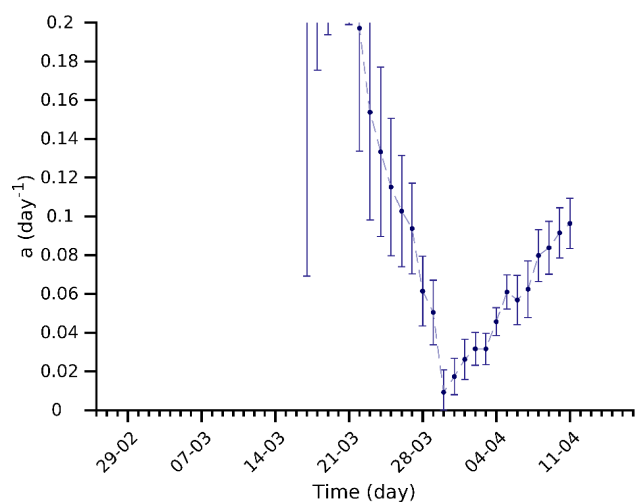
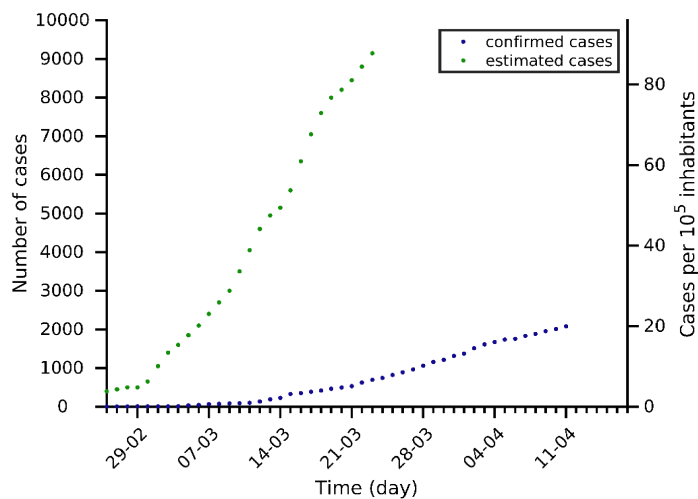
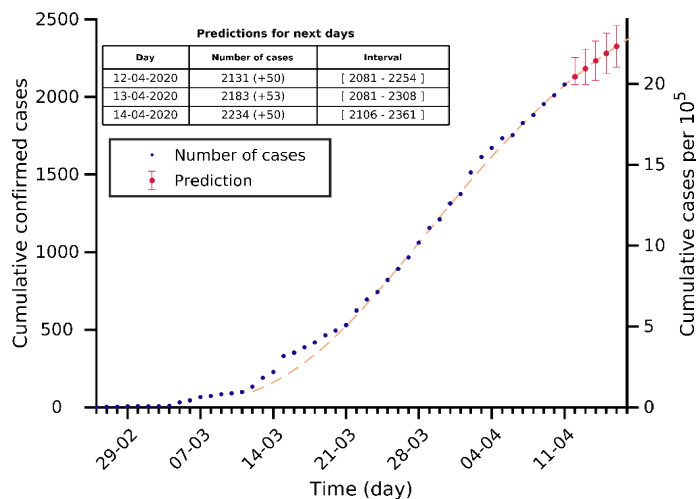
Luxembourg 11-04-2020. Population: 0.6M. Current cumulated incidence: 522/10⁵



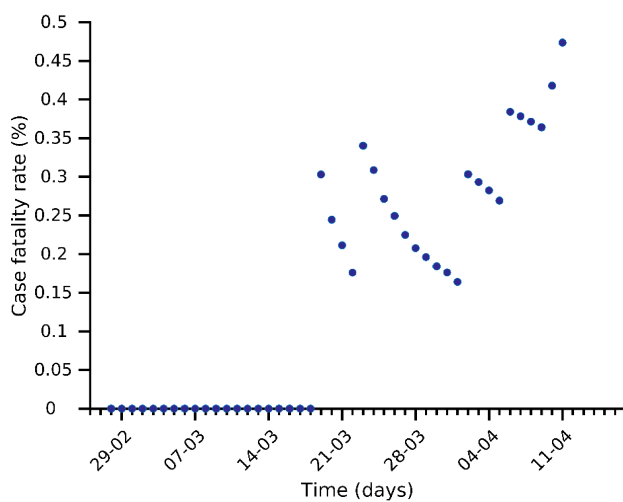
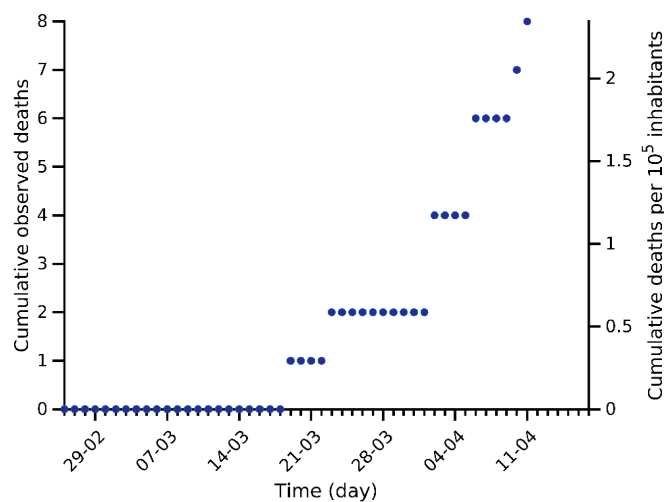
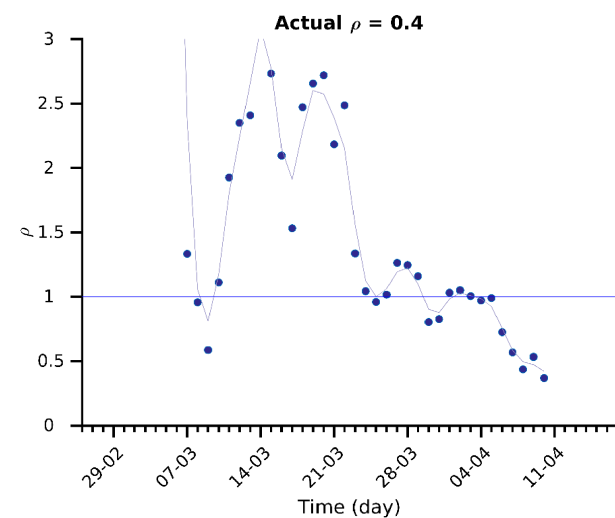
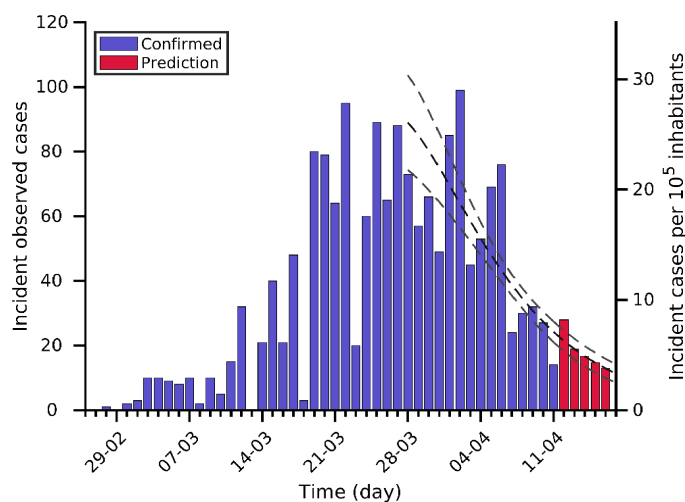
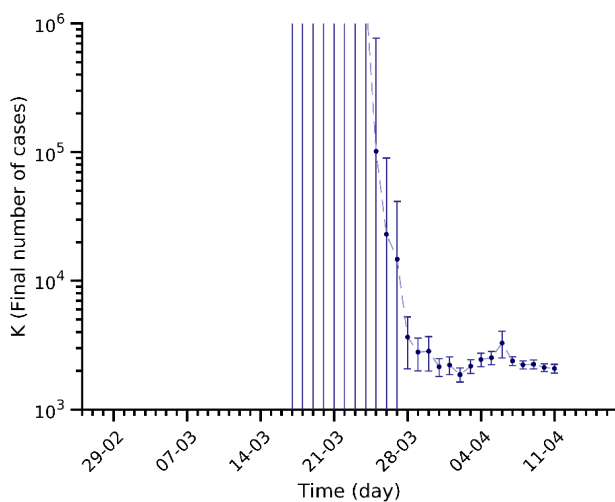
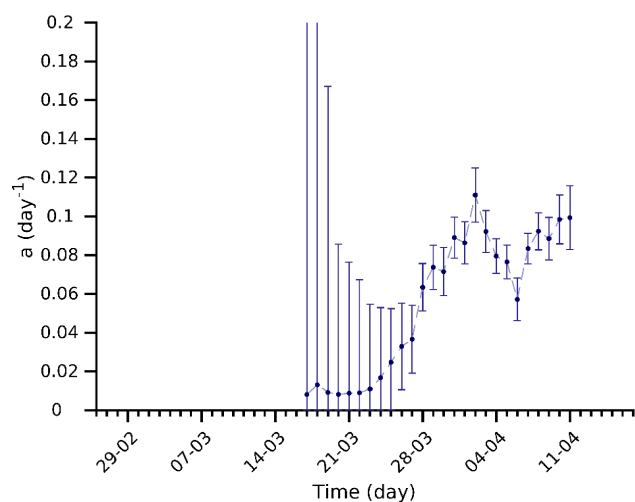
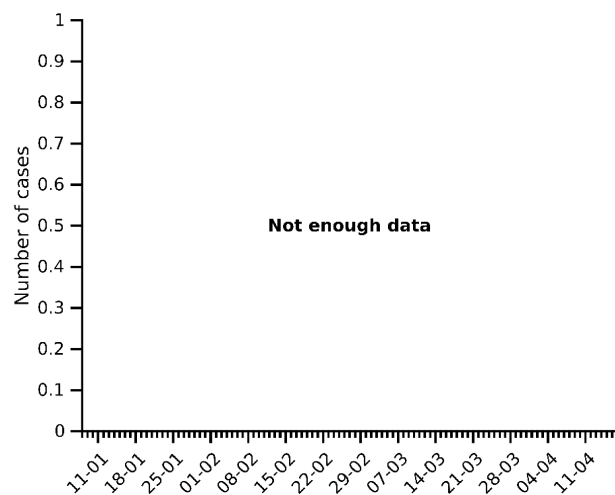
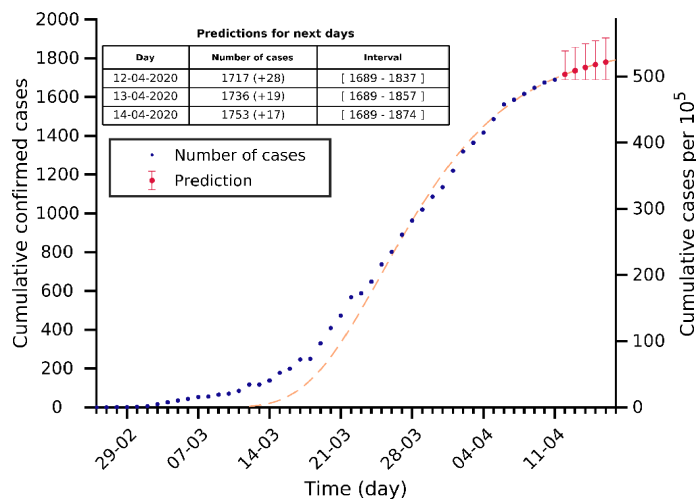
Finland 11-04-2020. Population: 5.5M. Current cumulated incidence: 52/10⁵



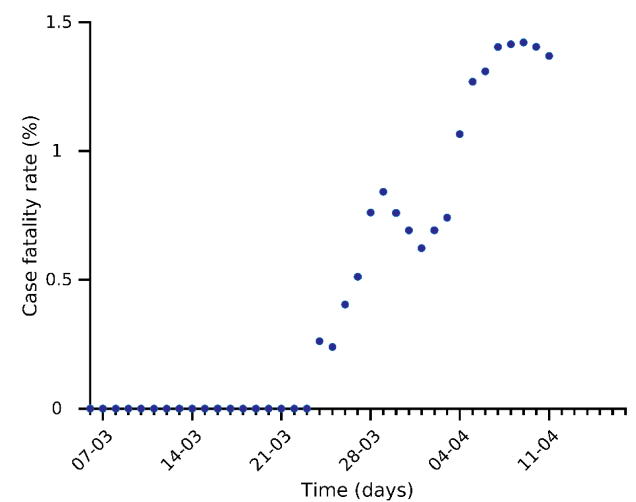
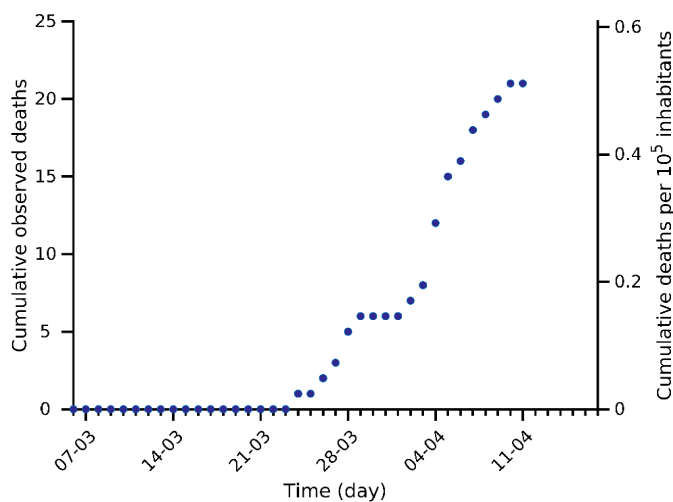
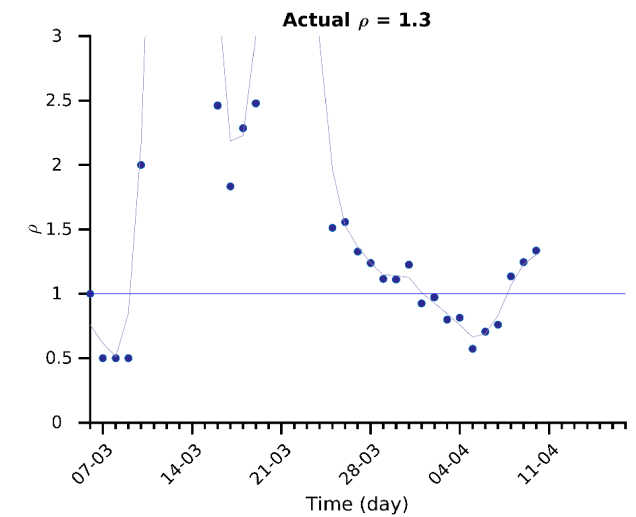
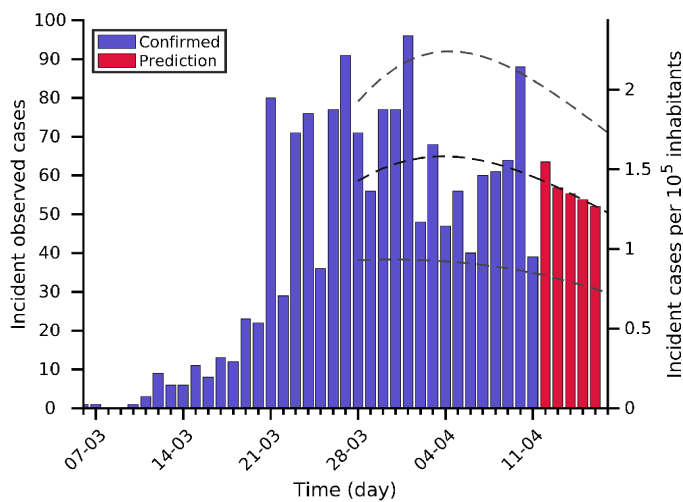
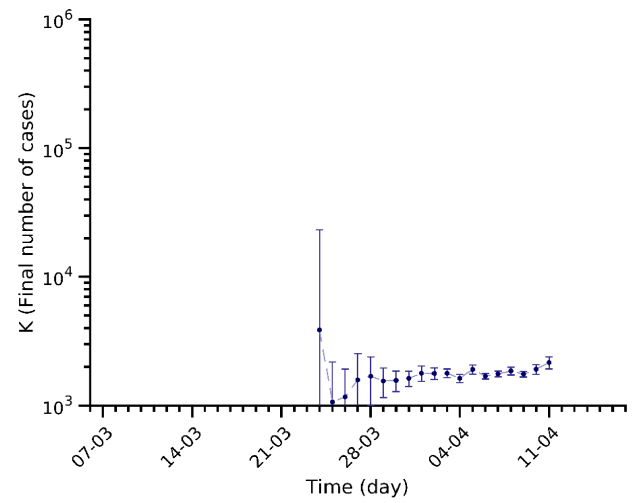
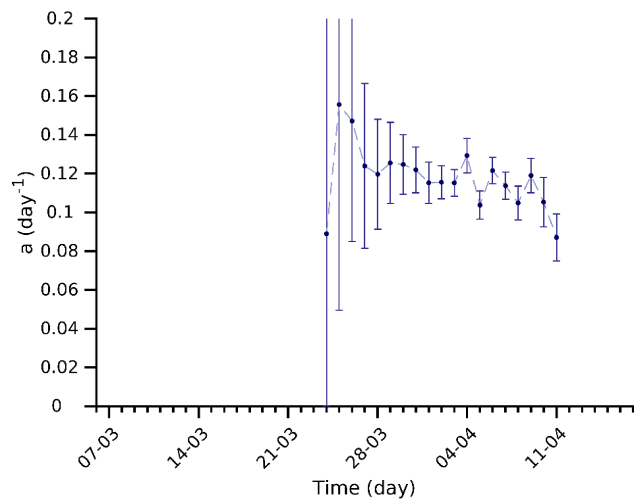
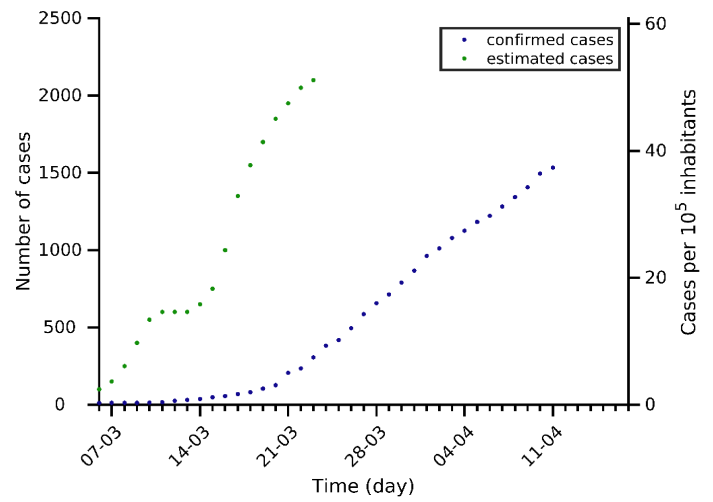
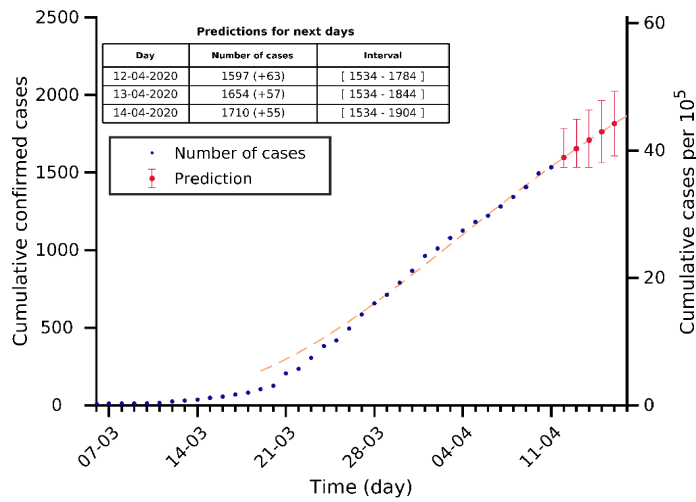
Greece 11-04-2020. Population: 10.4M. Current cumulated incidence: 20/10⁵



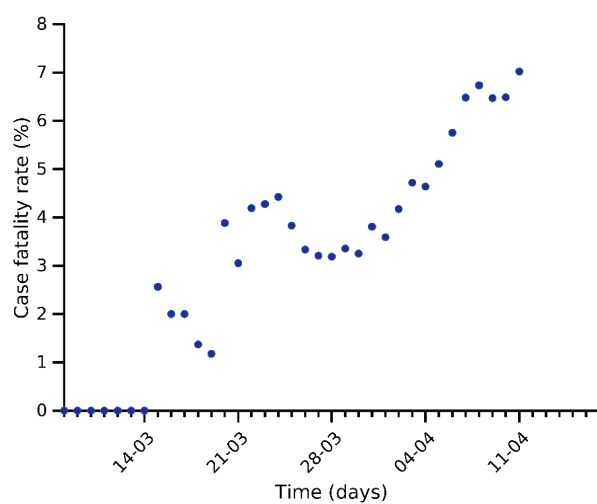
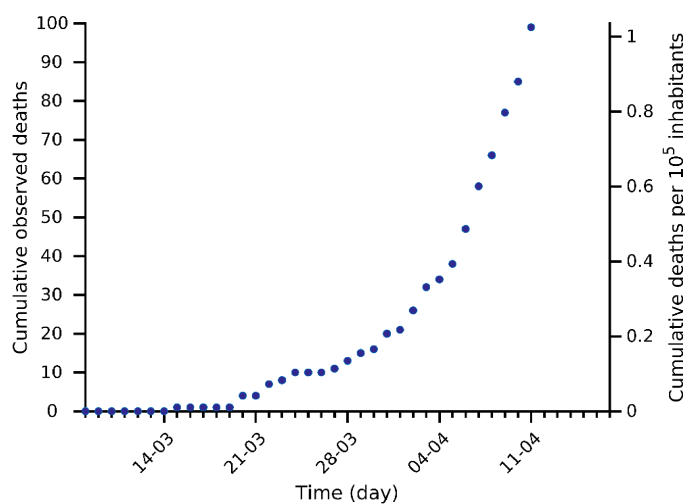
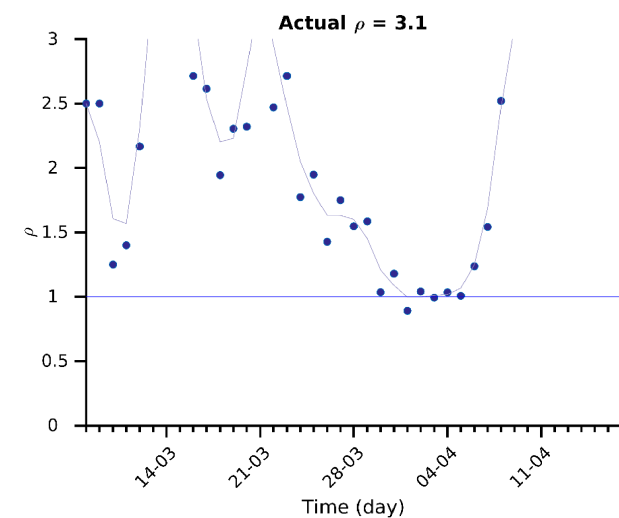
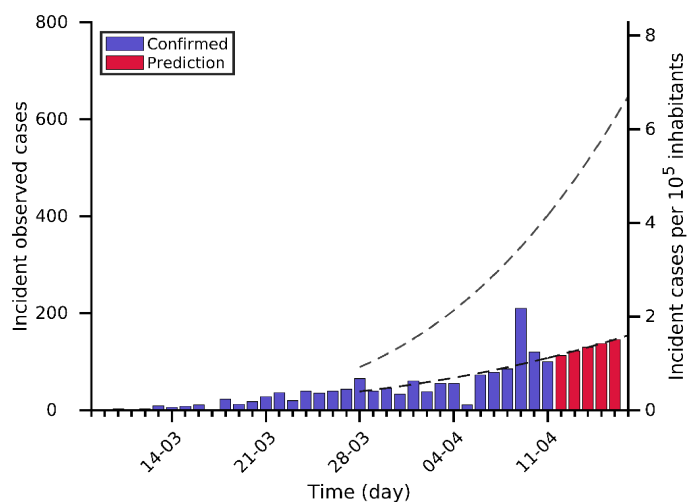
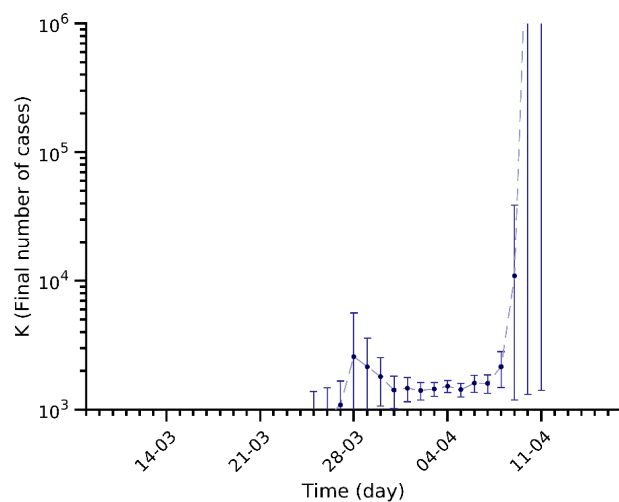
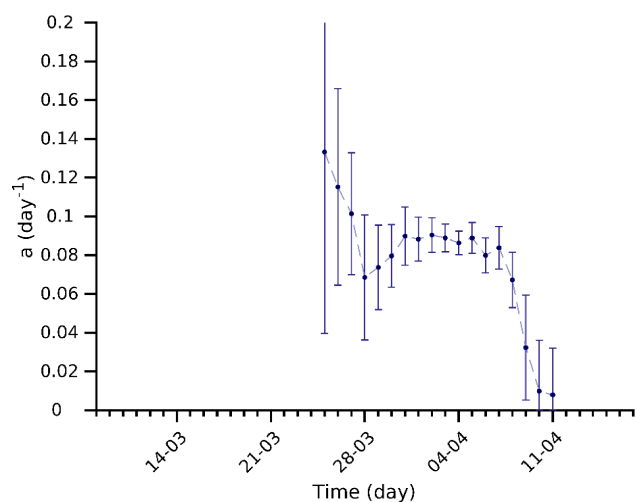
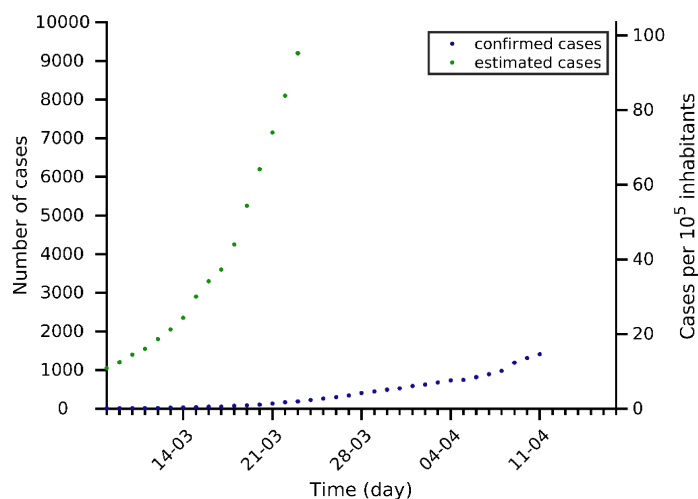
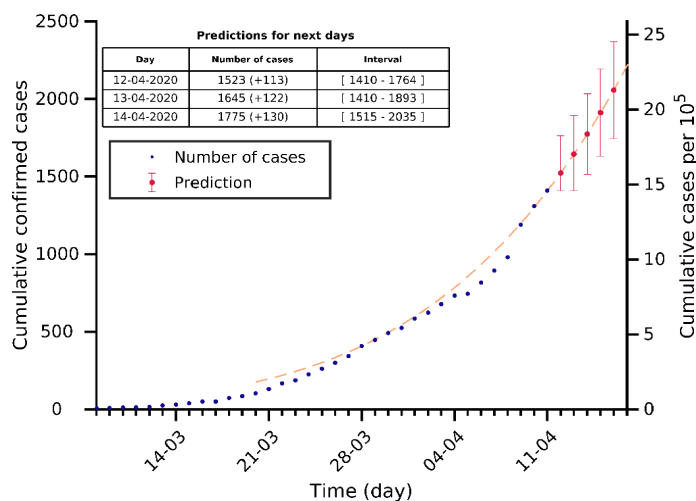
Iceland 11-04-2020. Population: 0.3M. Current cumulated incidence: 495/10⁵



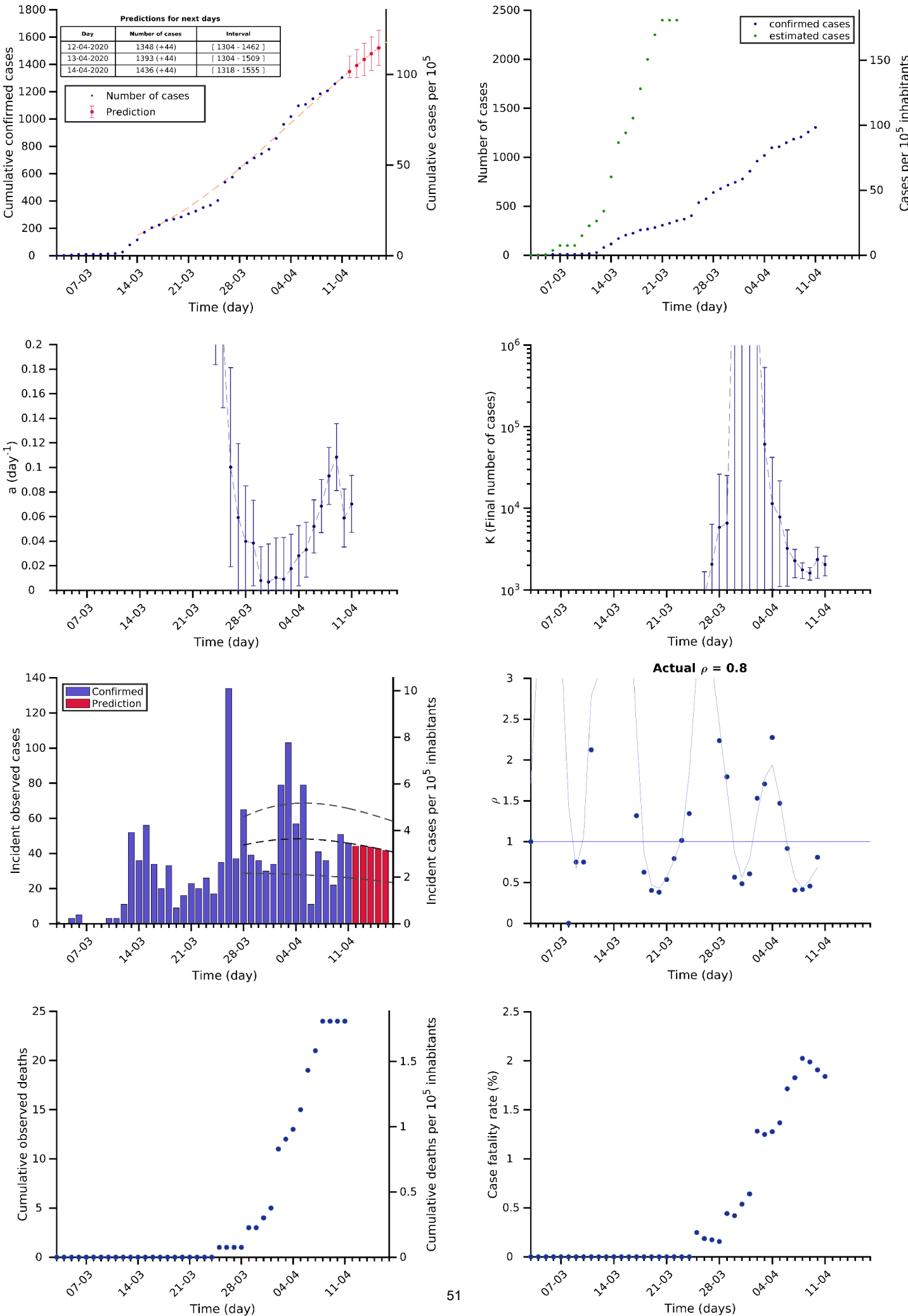
Croatia 11-04-2020. Population: 4.1M. Current cumulated incidence: 37/10⁵



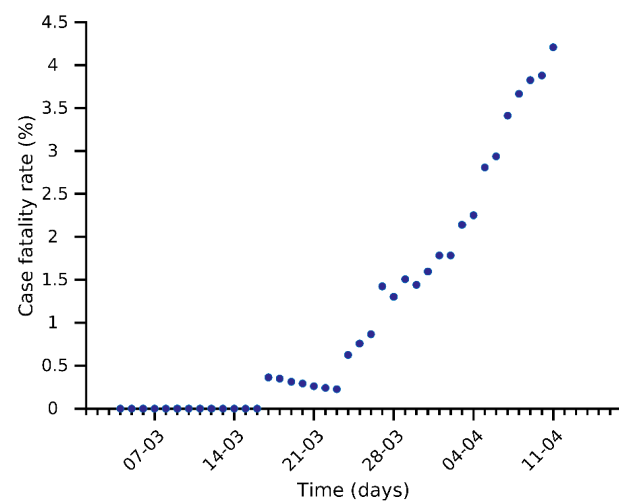
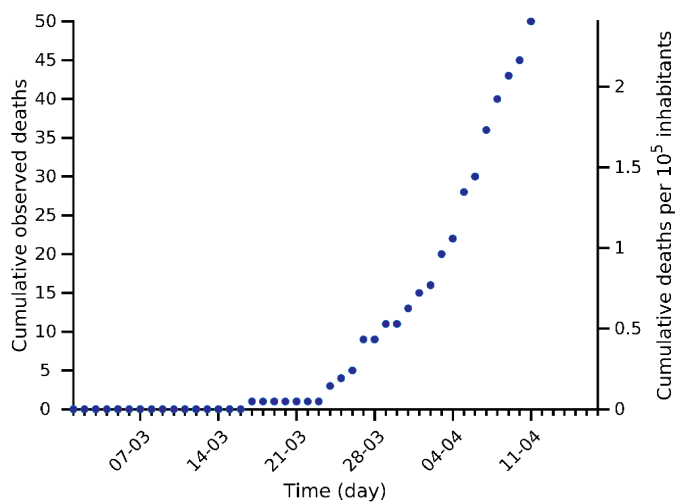
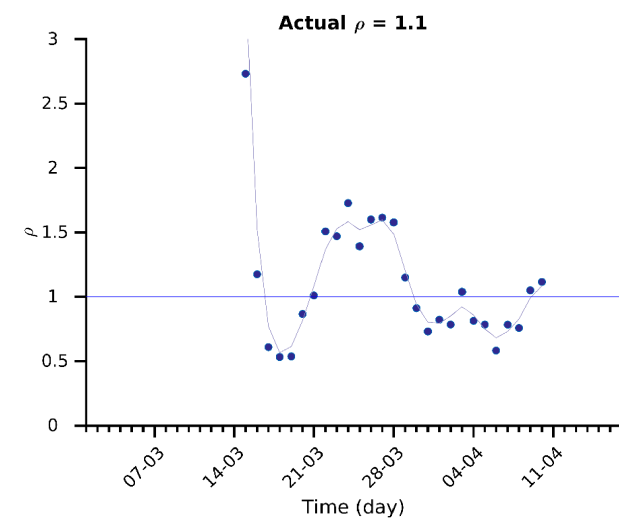
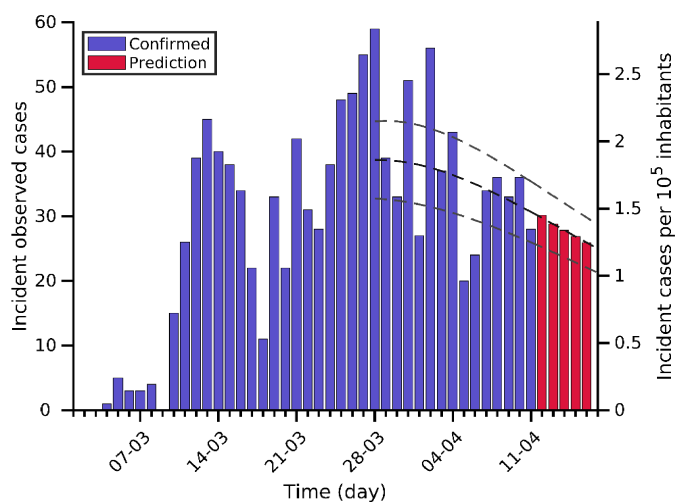
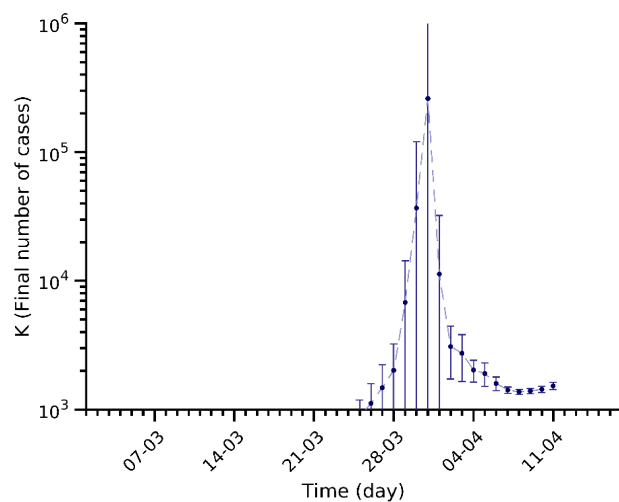
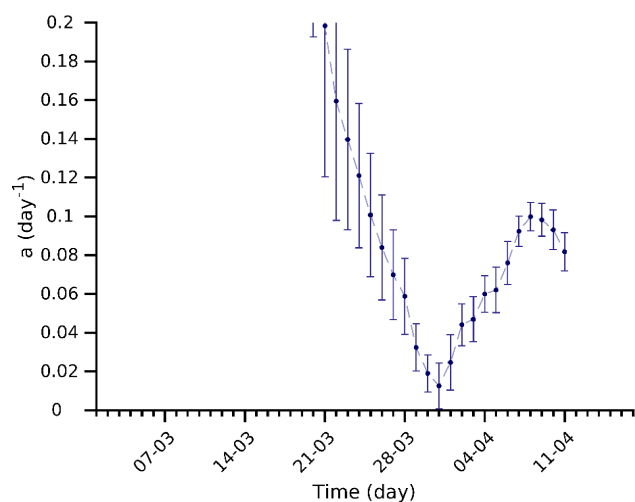
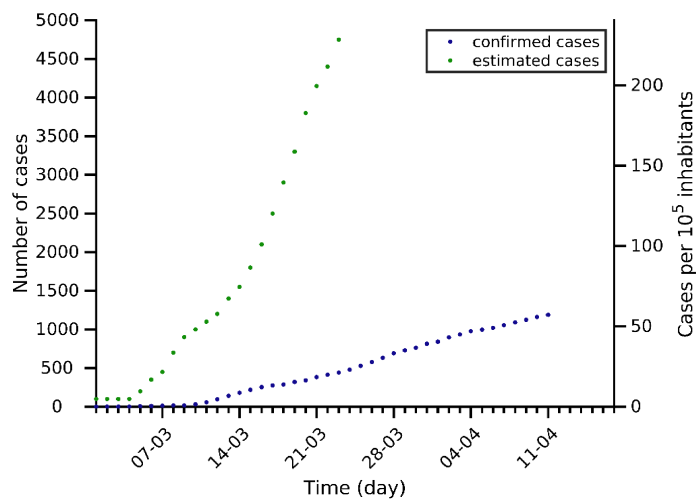
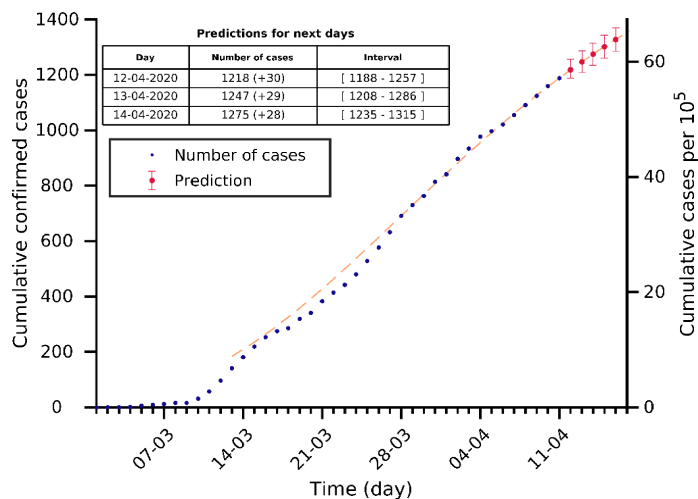
Hungary 11-04-2020. Population: 9.7M. Current cumulated incidence: 15/10⁵



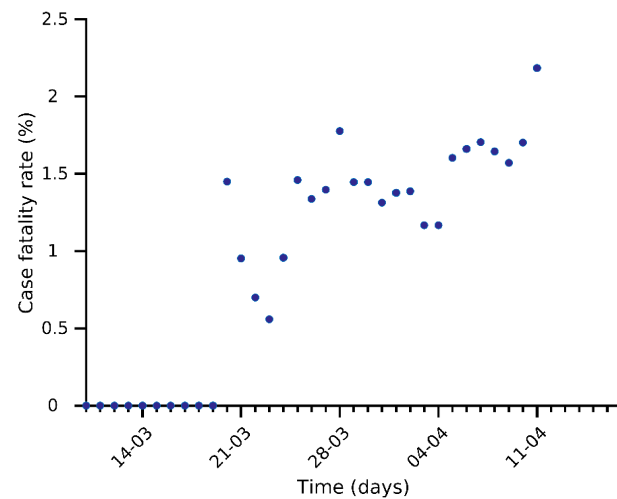
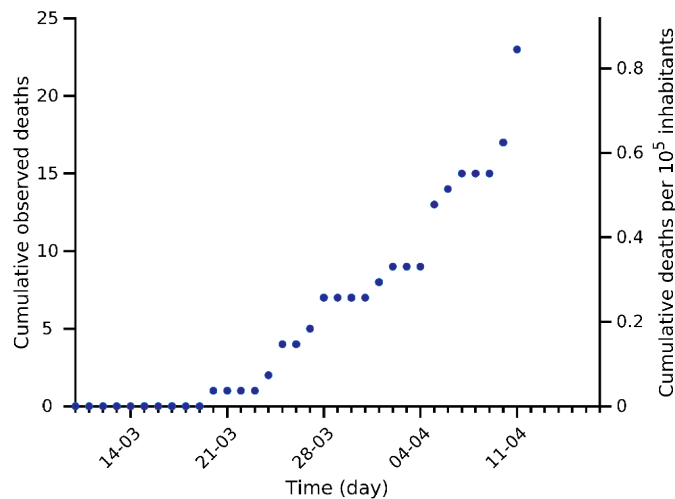
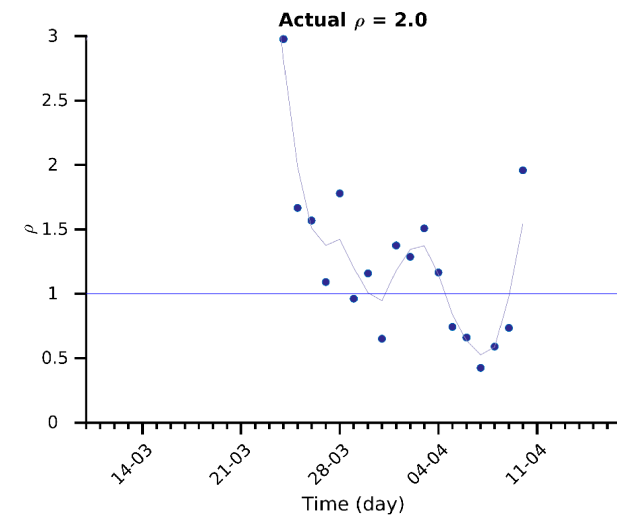
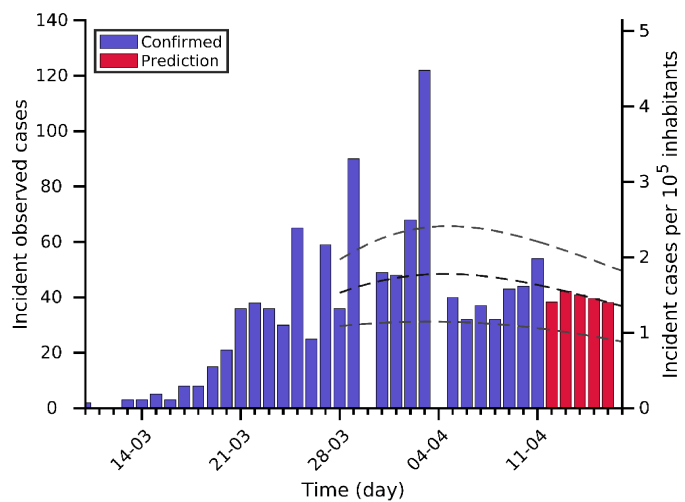
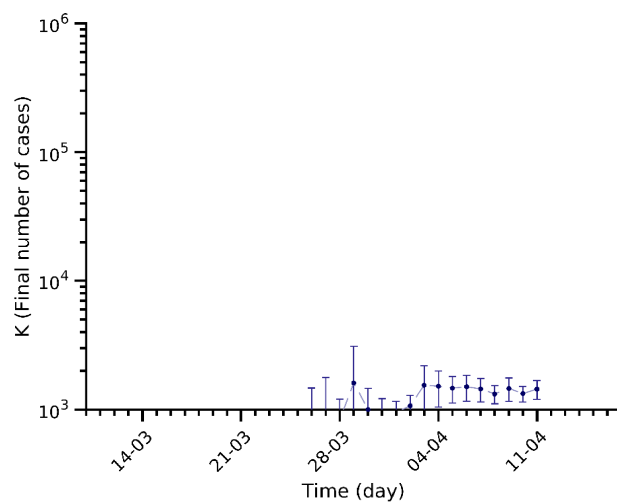
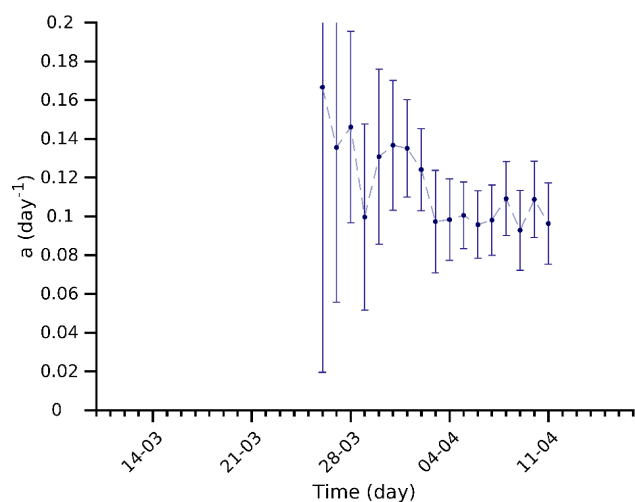
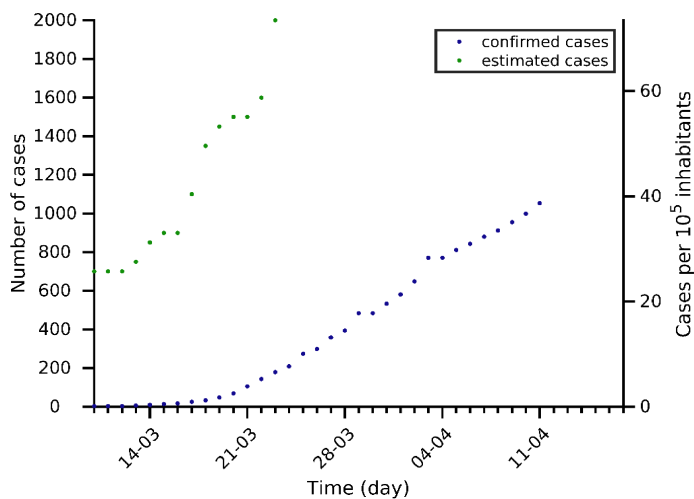
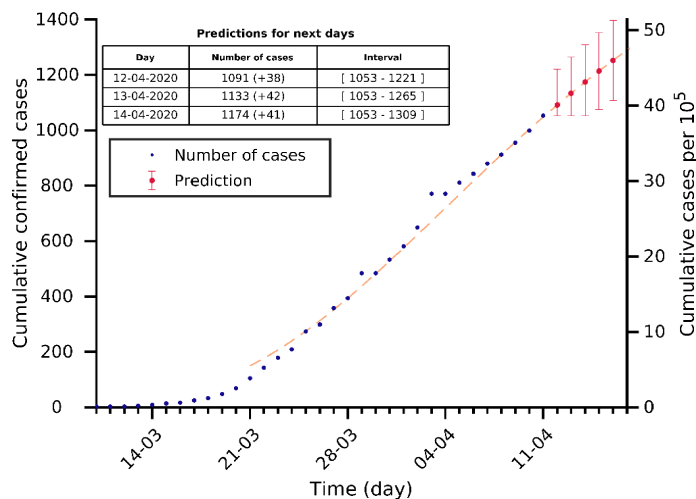
Estonia 11-04-2020. Population: 1.3M. Current cumulated incidence: 98/10⁵



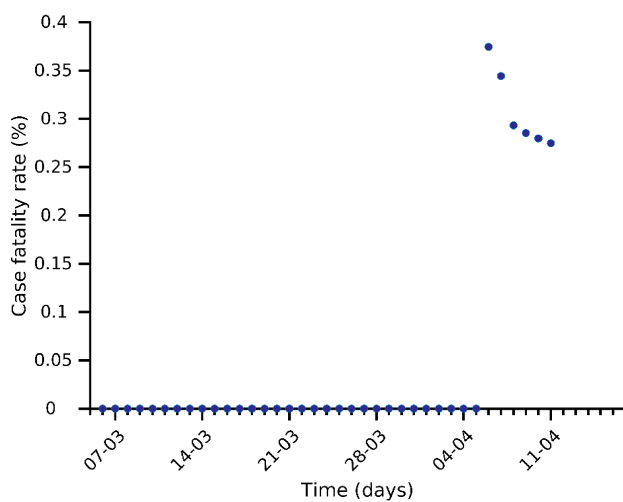
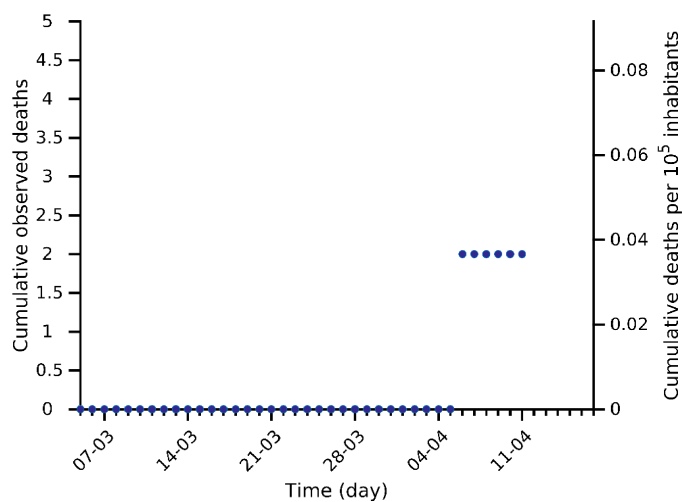
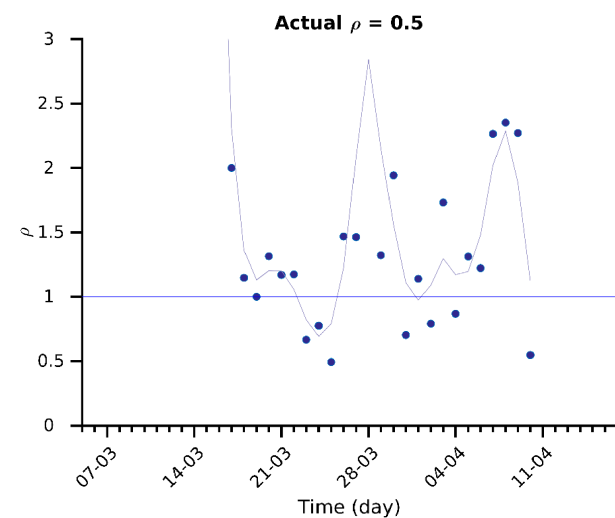
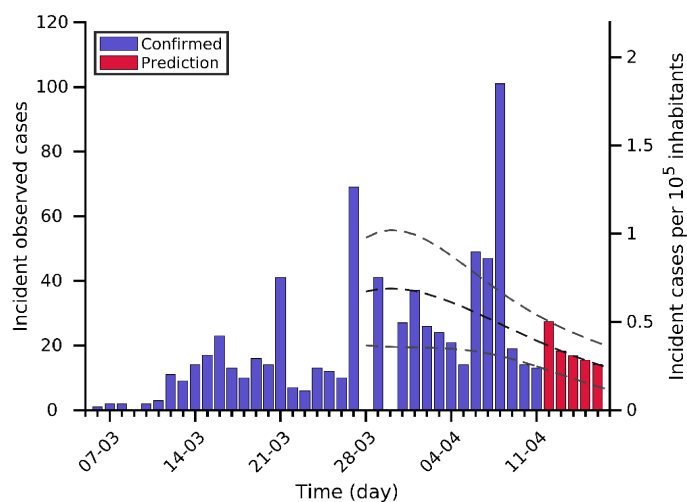
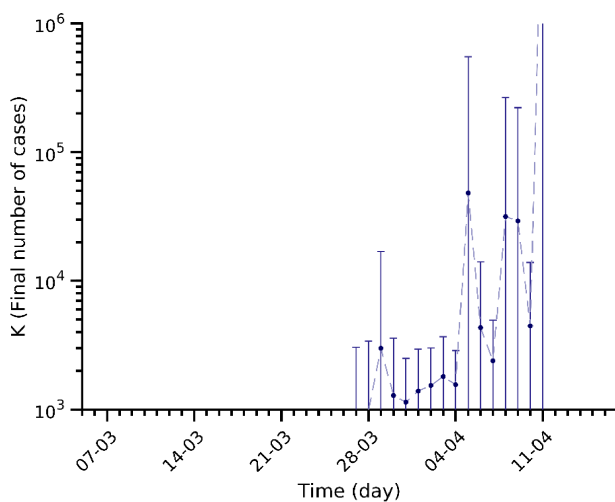
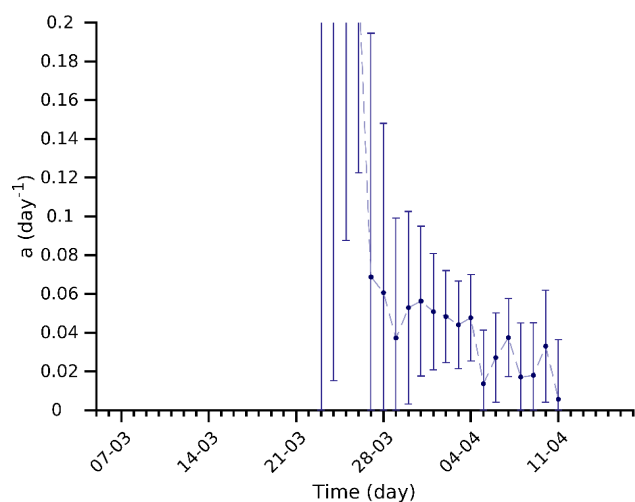
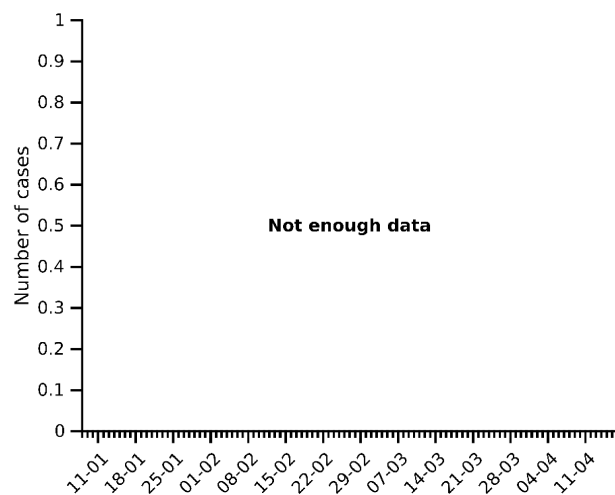
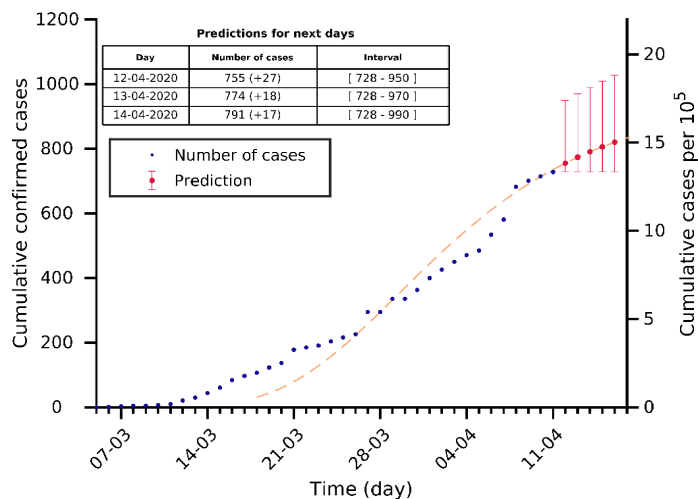
Slovenia 11-04-2020. Population: 2.1M. Current cumulated incidence: 57/10⁵



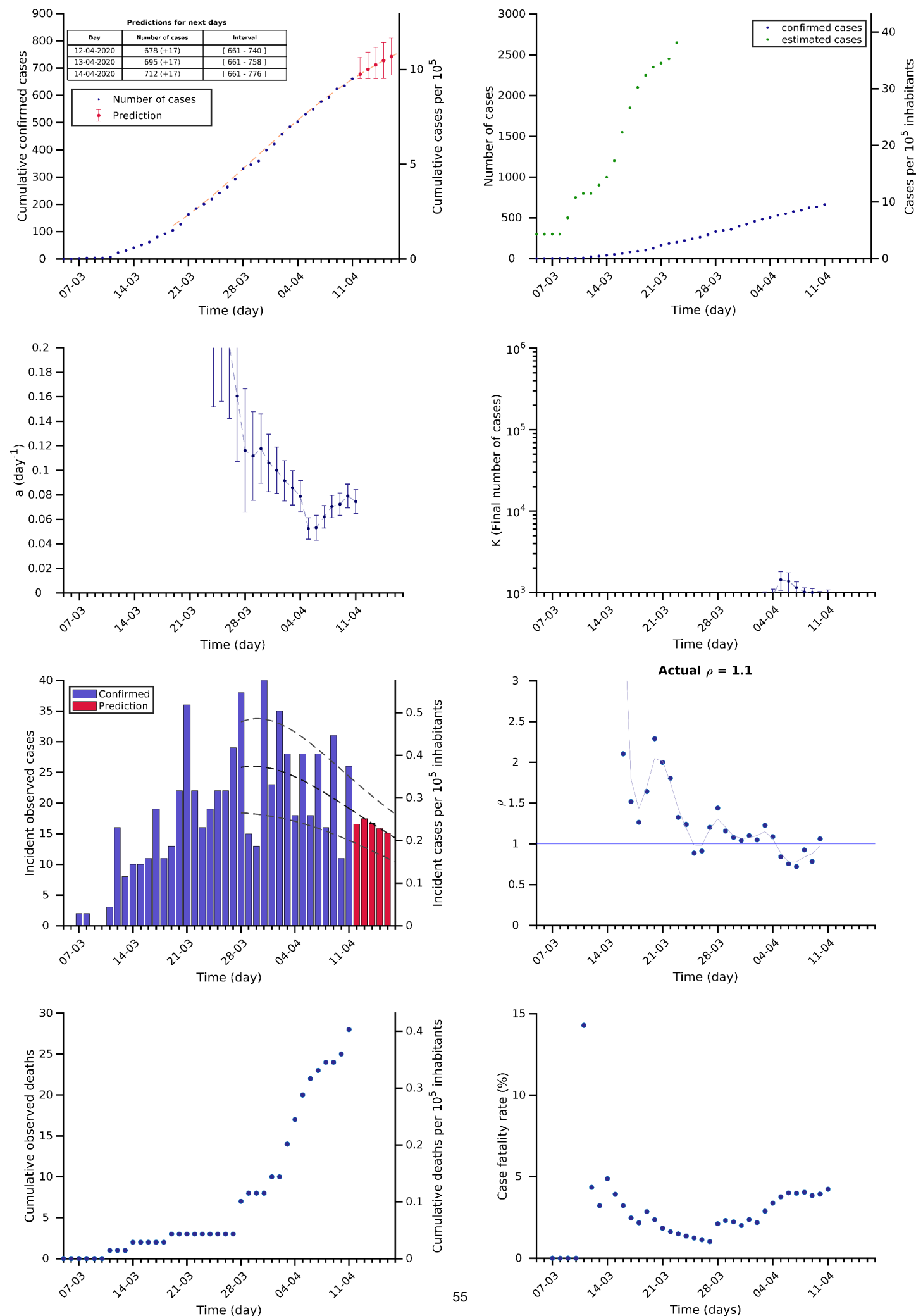
Lithuania 11-04-2020. Population: 2.7M. Current cumulated incidence: 39/10⁵



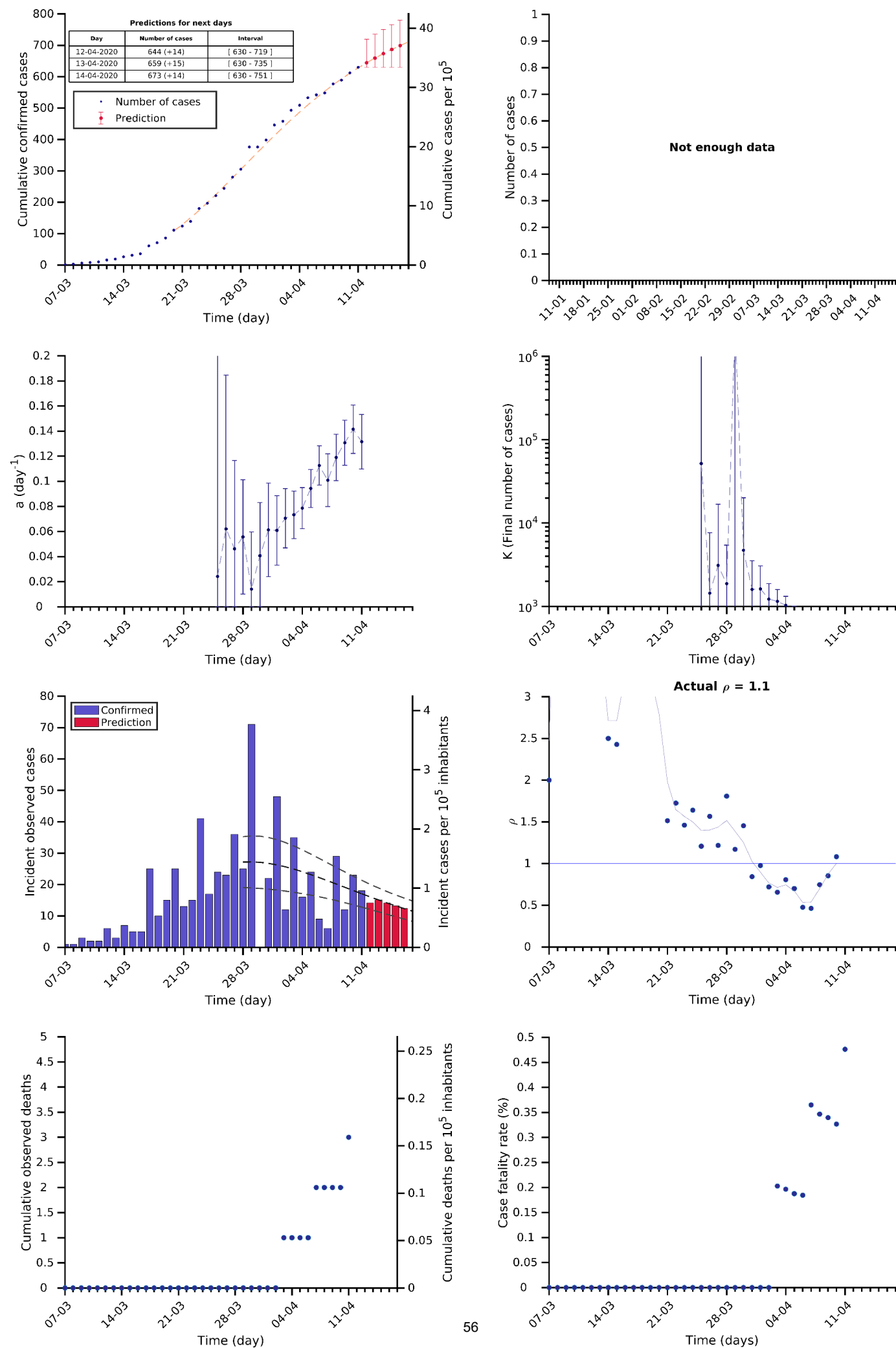
Slovakia 11-04-2020. Population: 5.5M. Current cumulated incidence: 13/10⁵



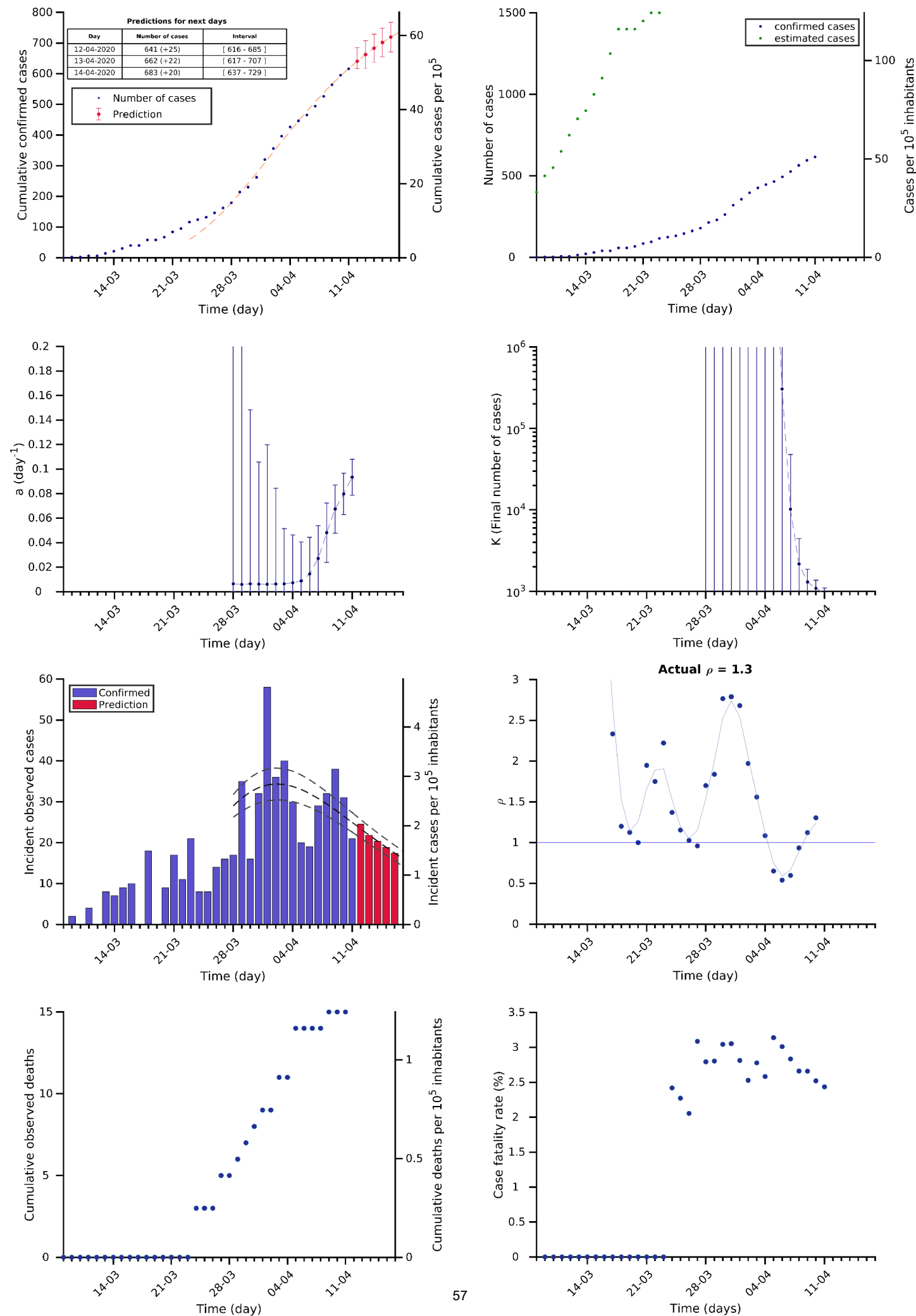
Bulgaria 11-04-2020. Population: 6.9M. Current cumulated incidence: 10/10⁵



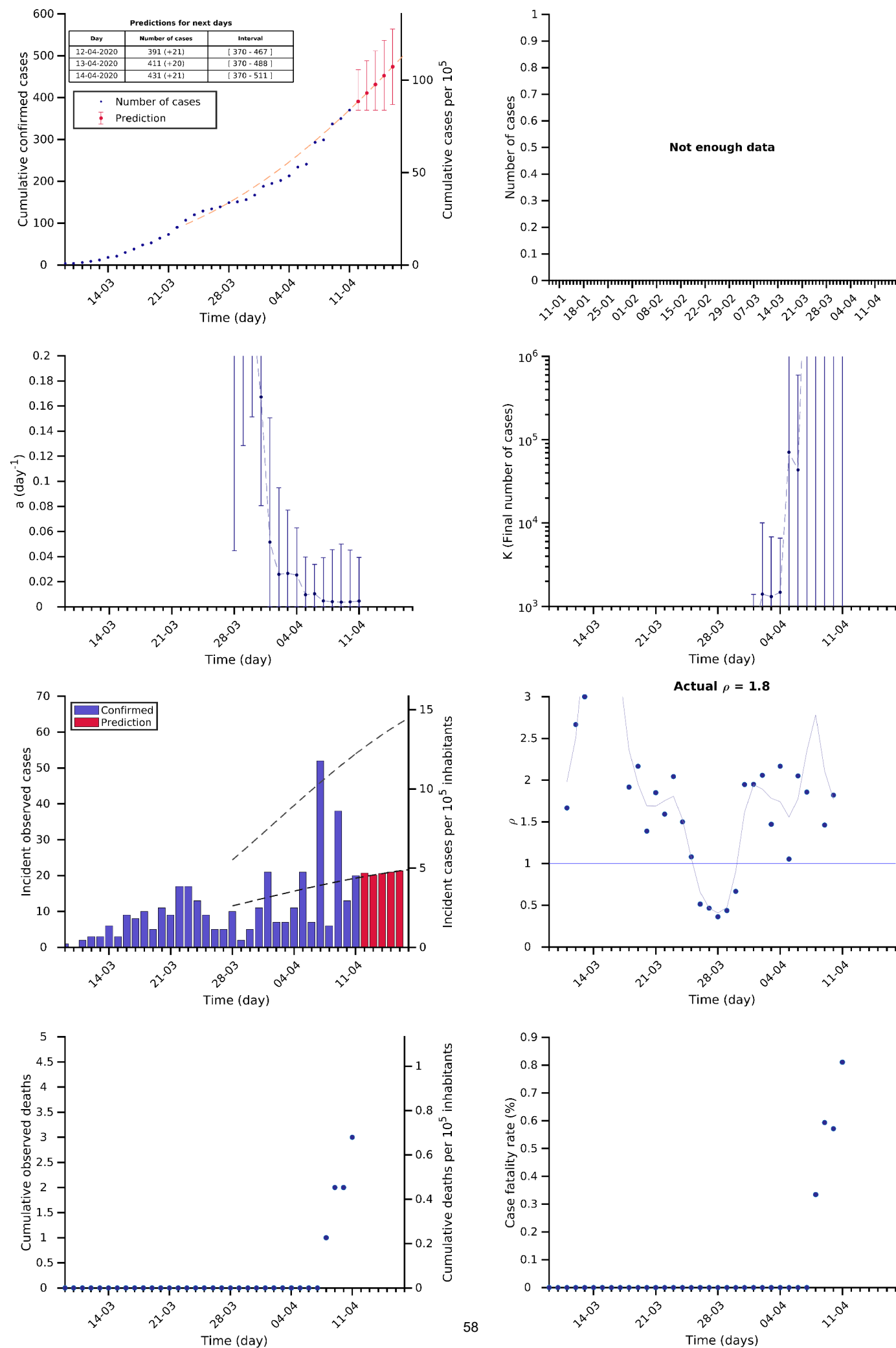
Latvia 11-04-2020. Population: 1.9M. Current cumulated incidence: 33/10⁵



Cyprus 11-04-2020. Population: 1.2M. Current cumulated incidence: 51/10⁵



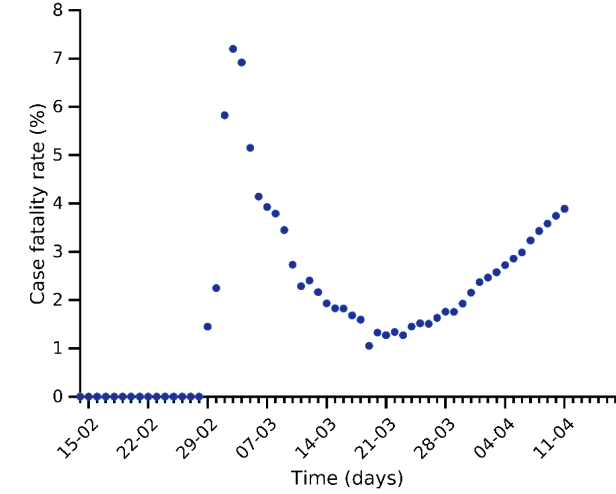
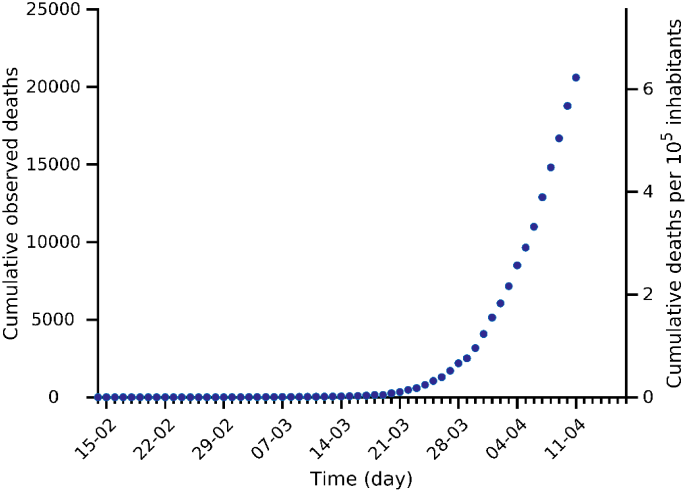
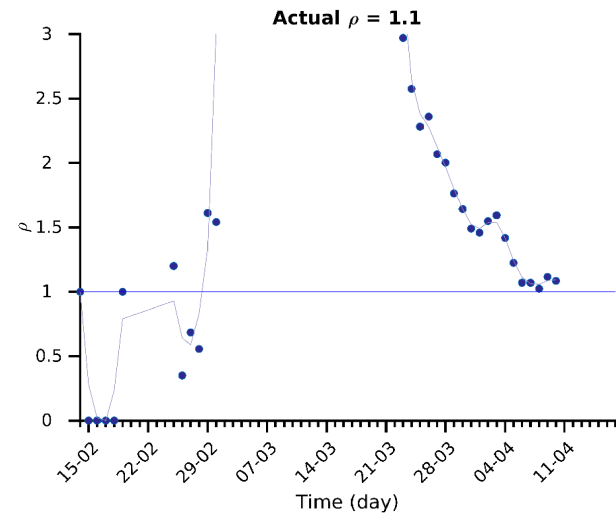
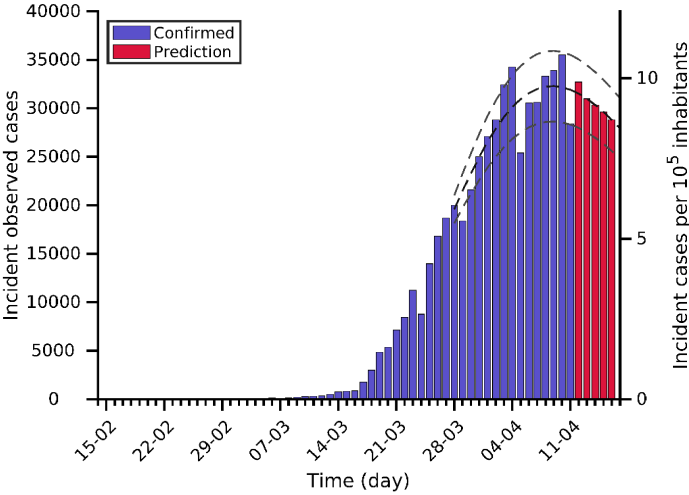
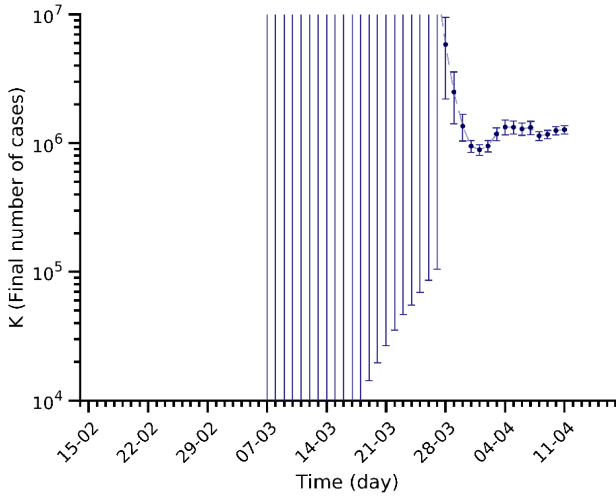
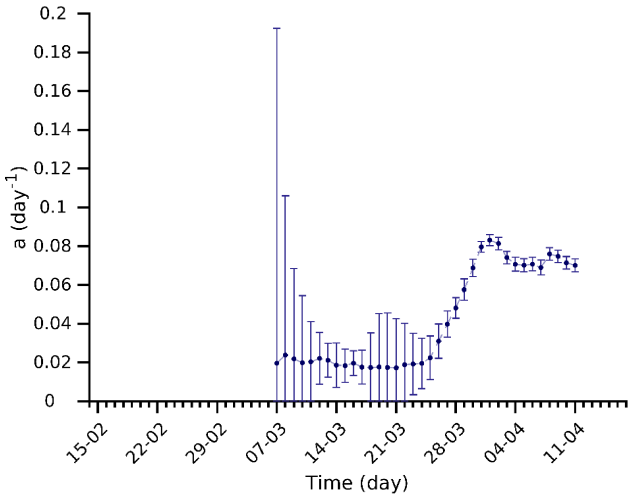
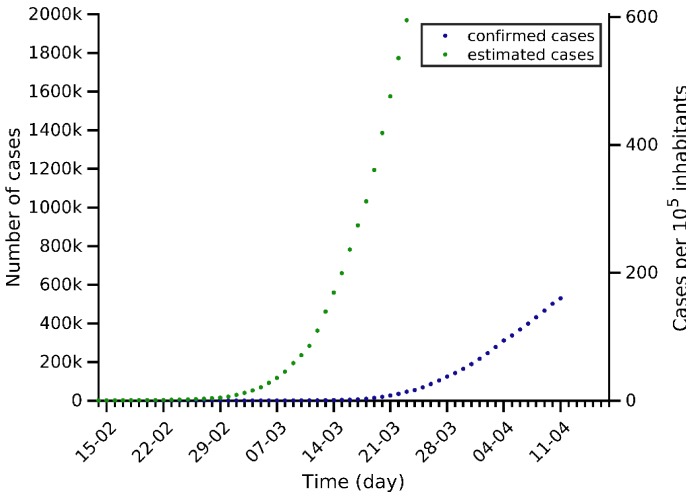
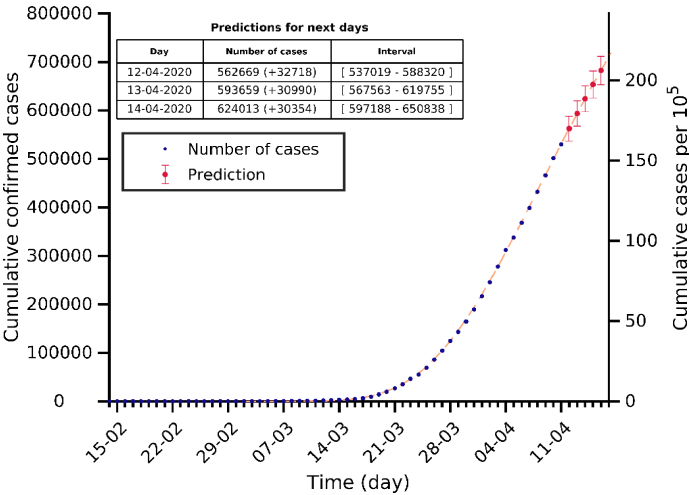
Malta 11-04-2020. Population: 0.4M. Current cumulated incidence: 84/10⁵



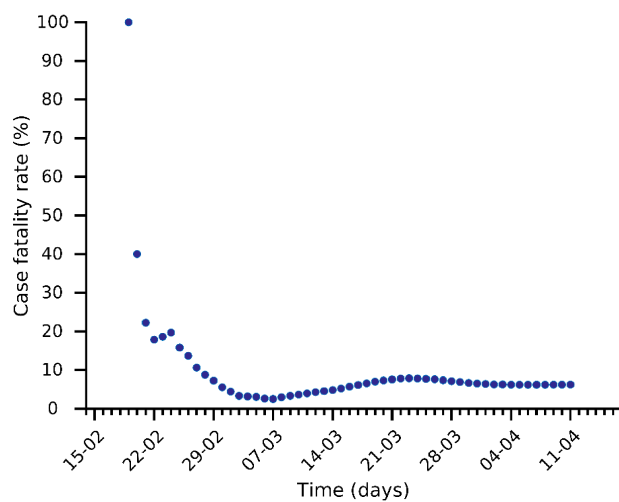
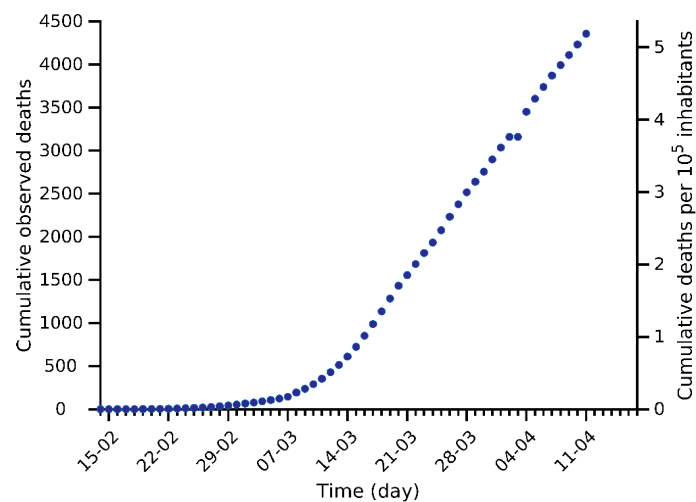
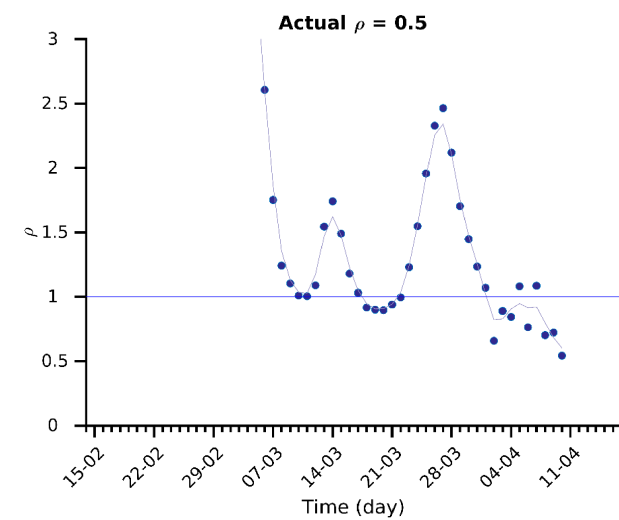
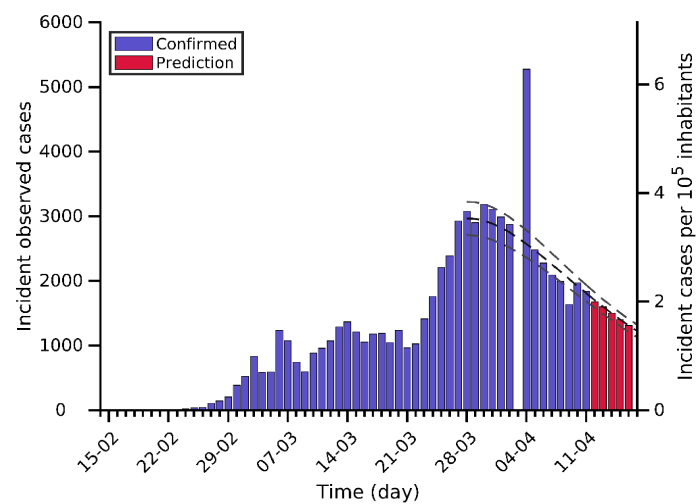
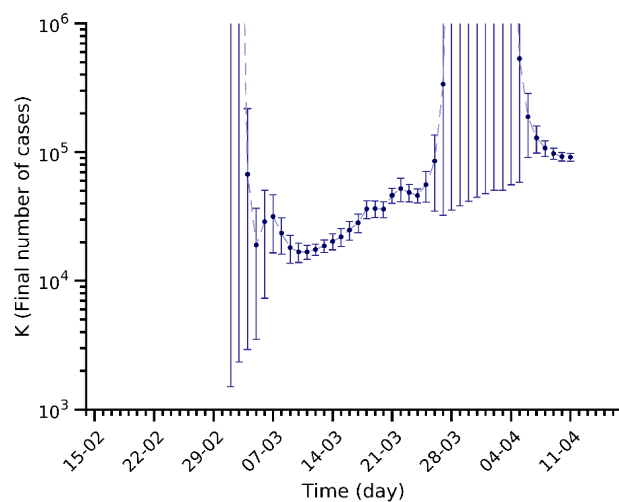
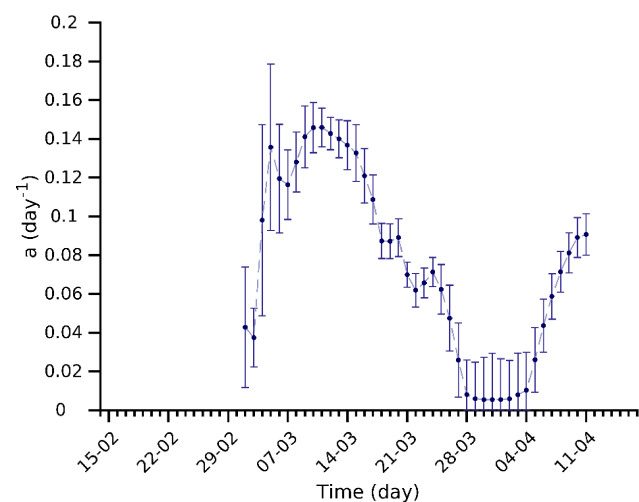
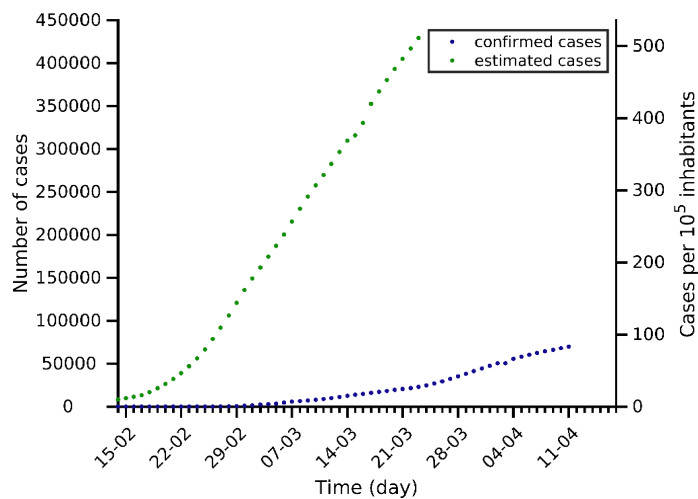
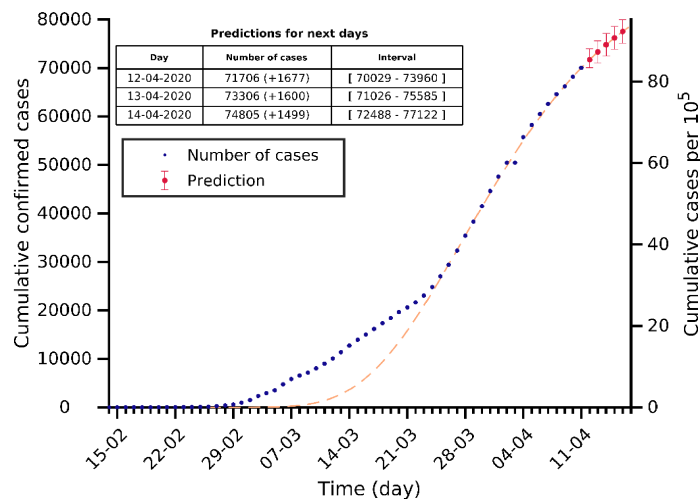
(2) Analysis and prediction of COVID-19 for other countries

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

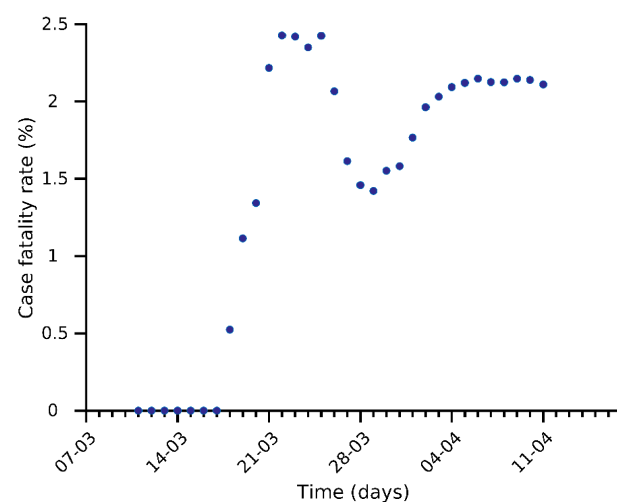
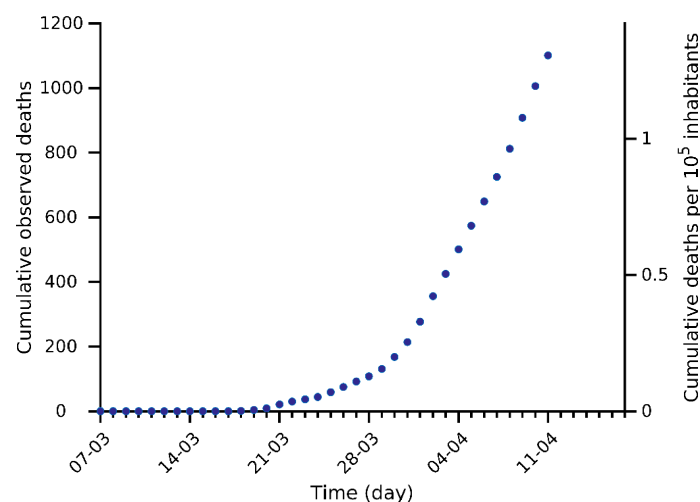
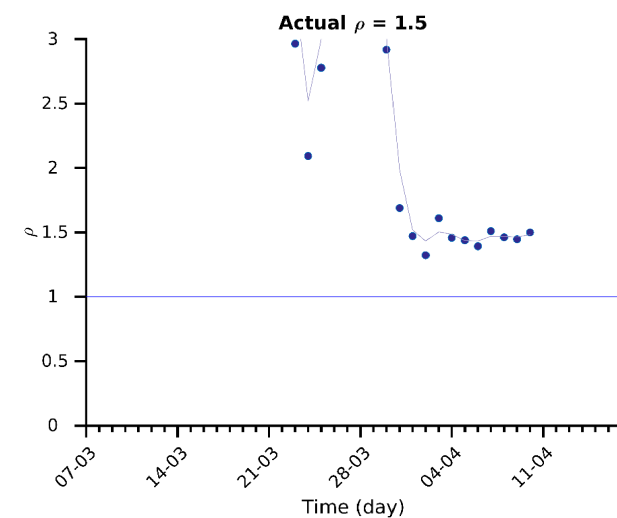
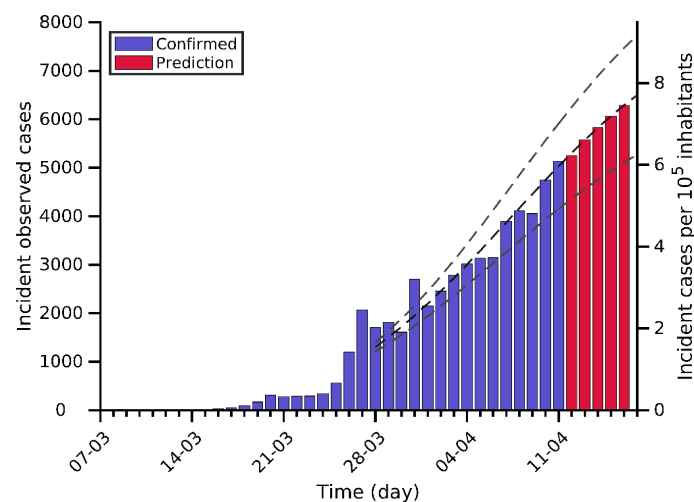
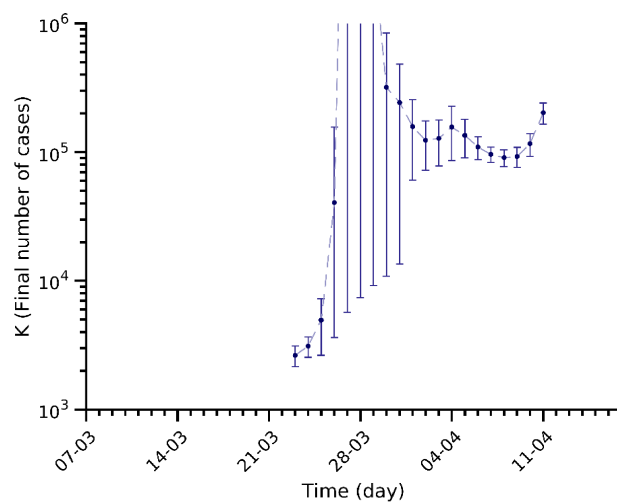
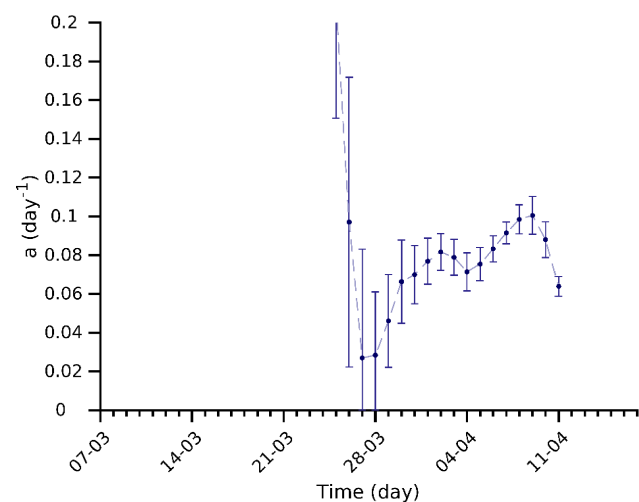
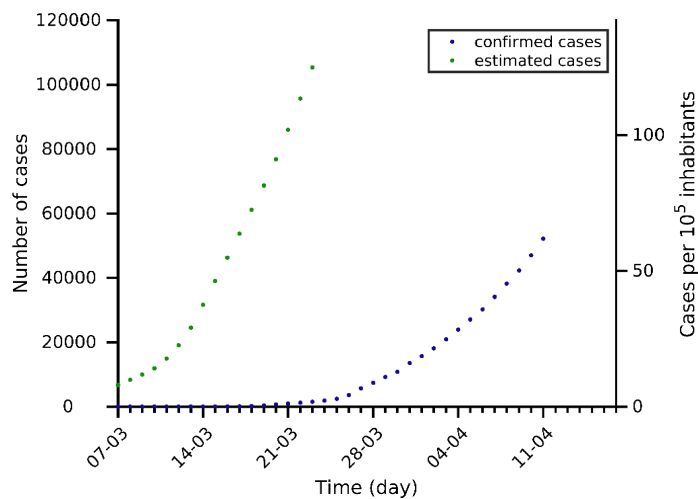
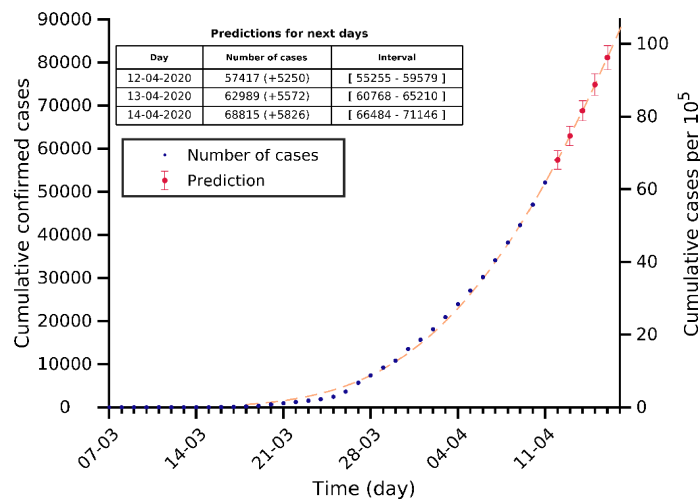
USA 11-04-2020. Population: 331.0M. Current cumulated incidence: 160/10⁵



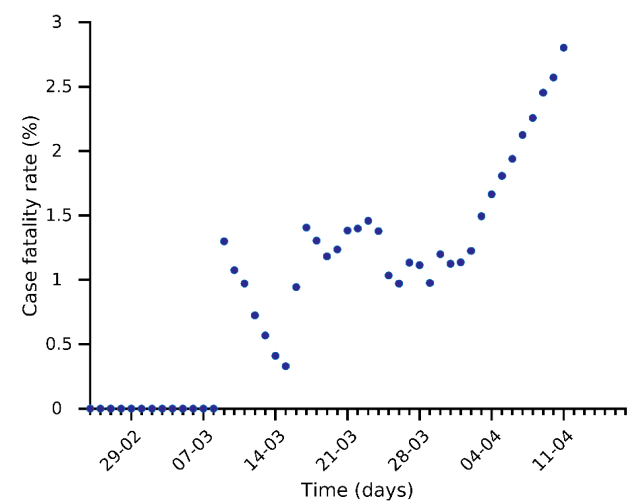
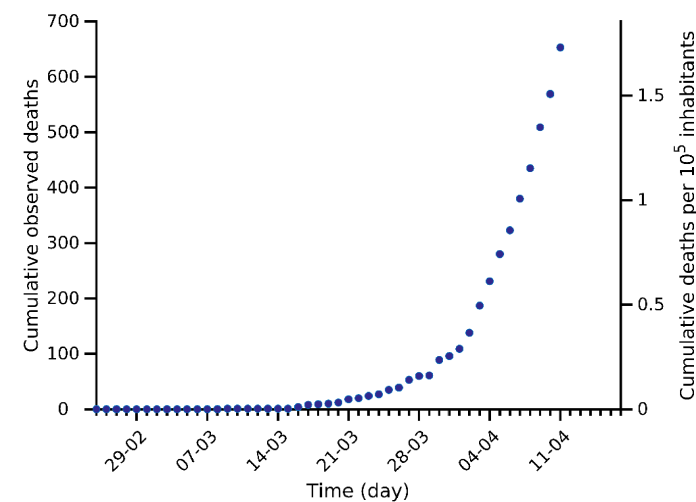
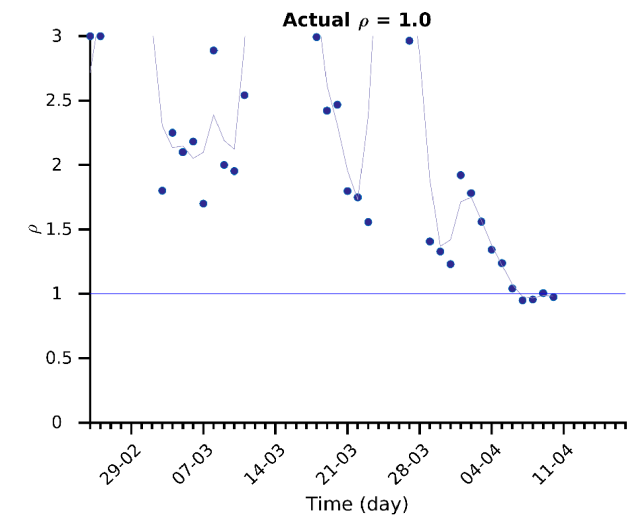
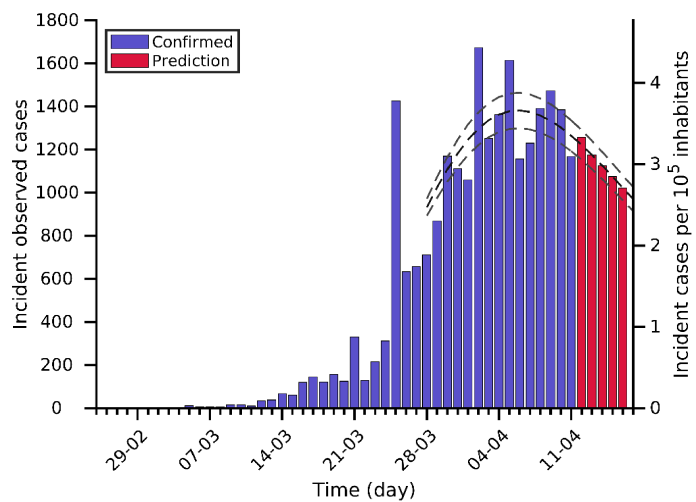
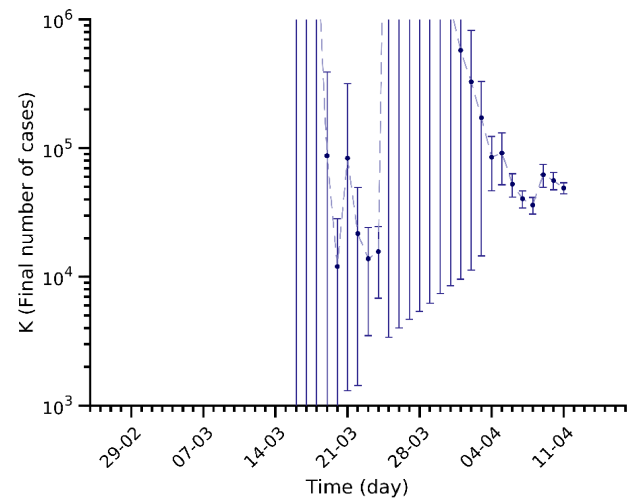
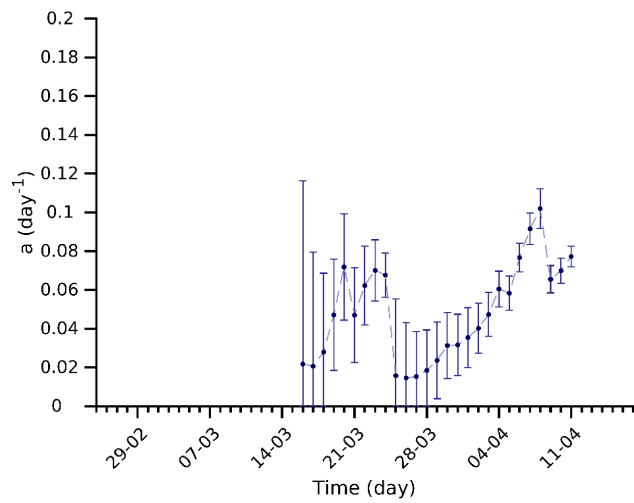
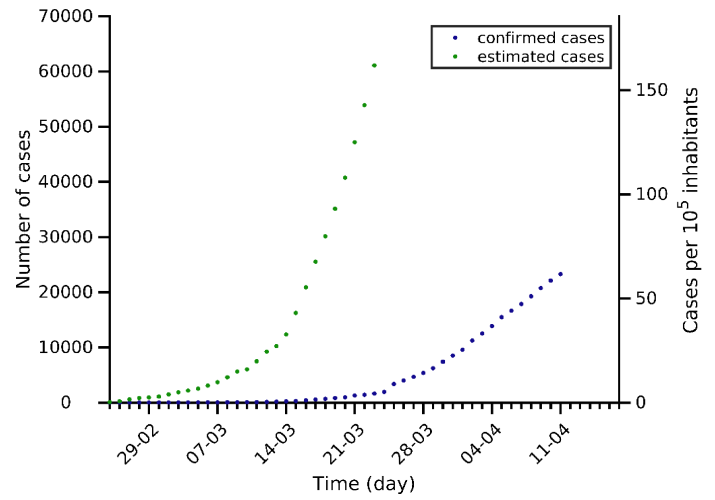
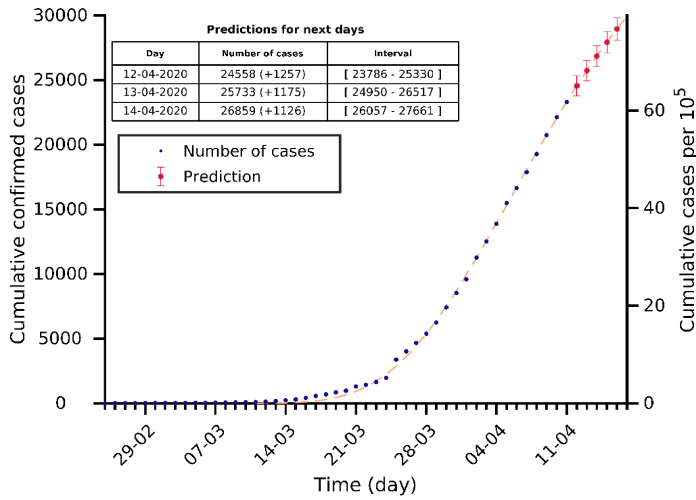
Iran 11-04-2020. Population: 84.0M. Current cumulated incidence: 83/10⁵



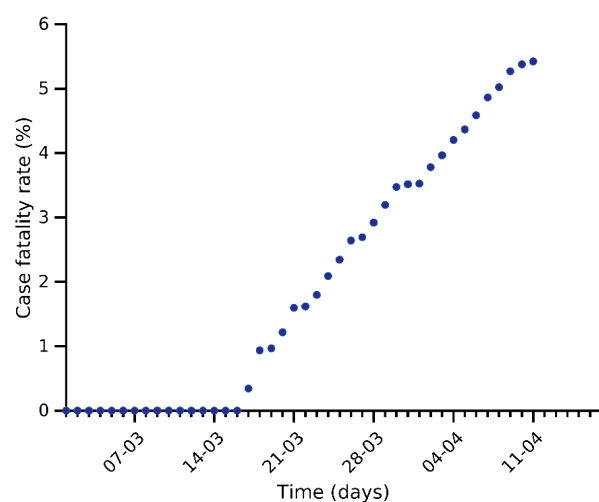
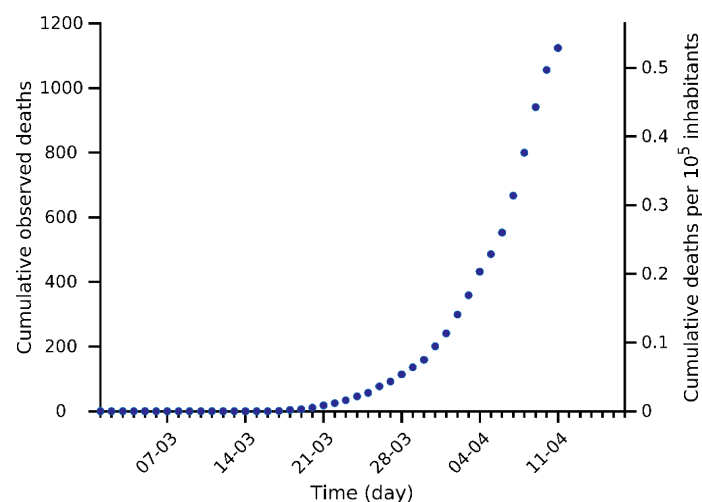
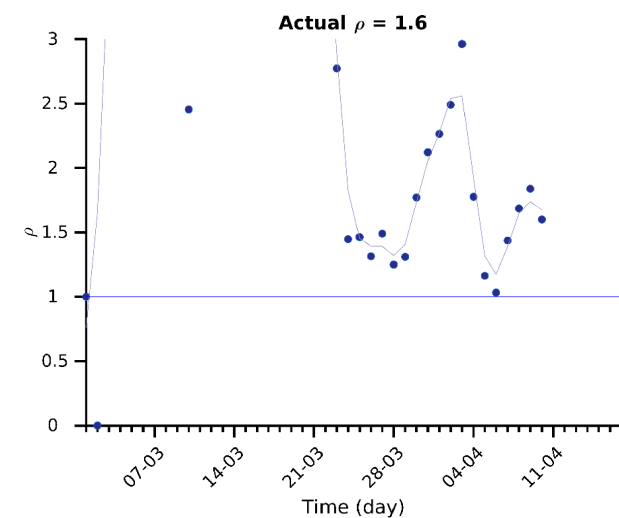
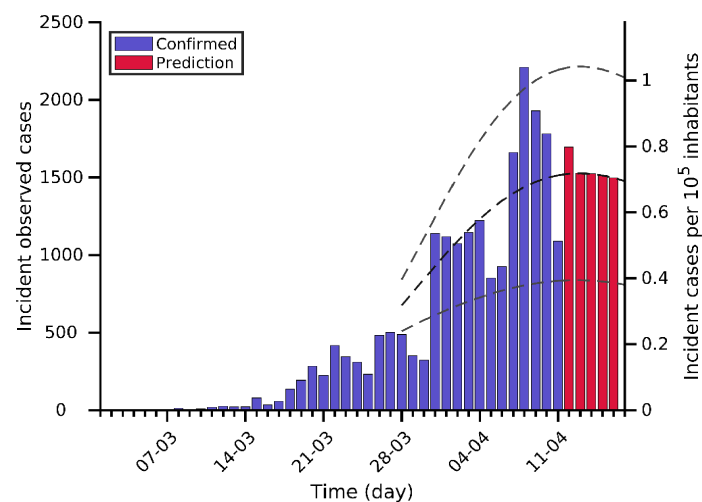
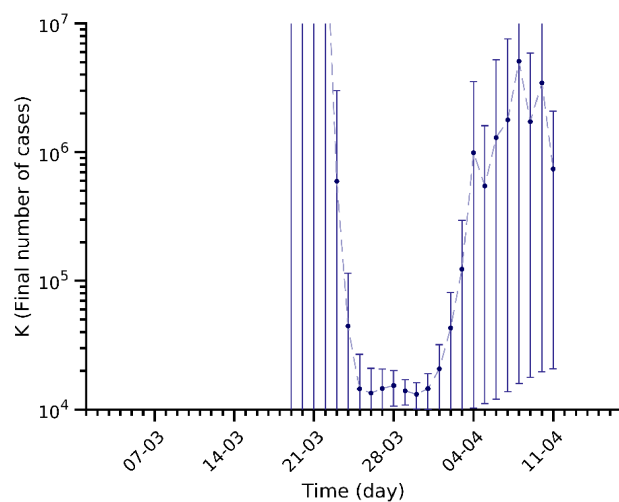
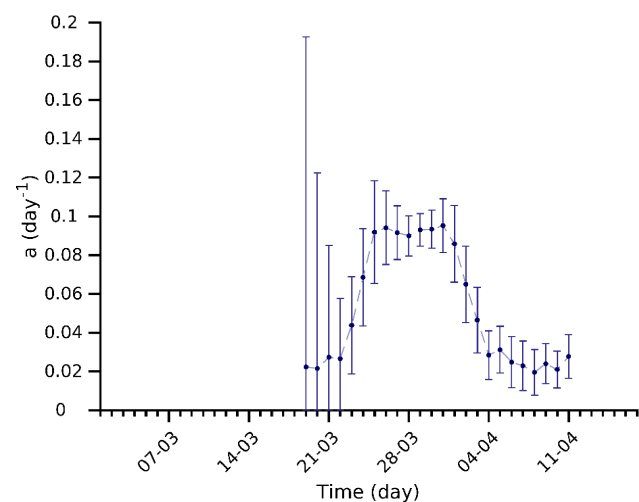
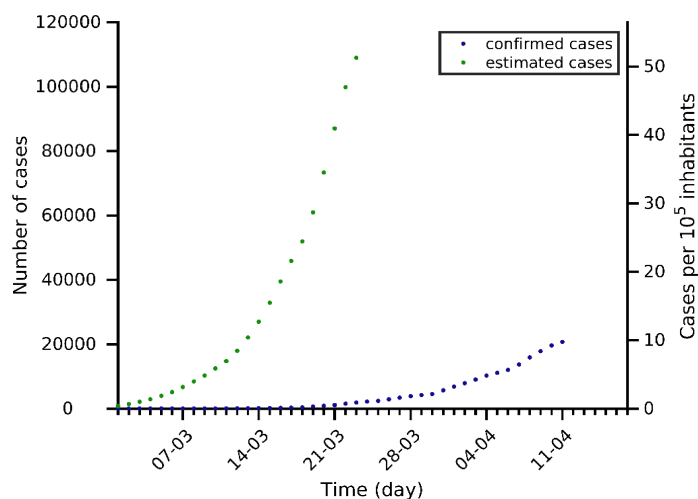
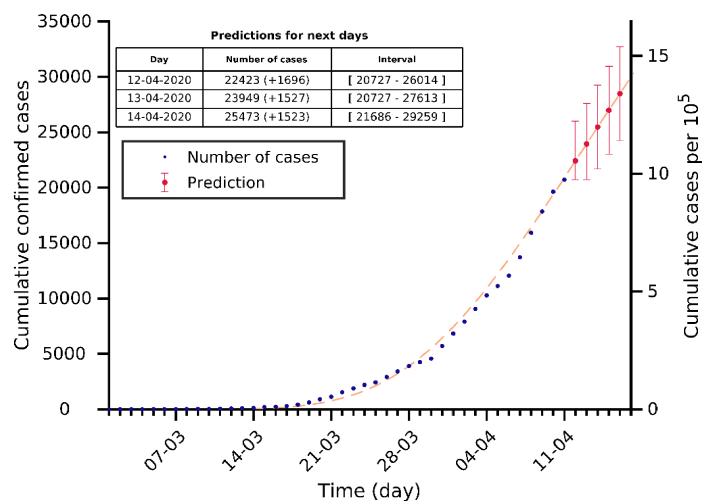
Turkey 11-04-2020. Population: 84.3M. Current cumulated incidence: 62/10⁵



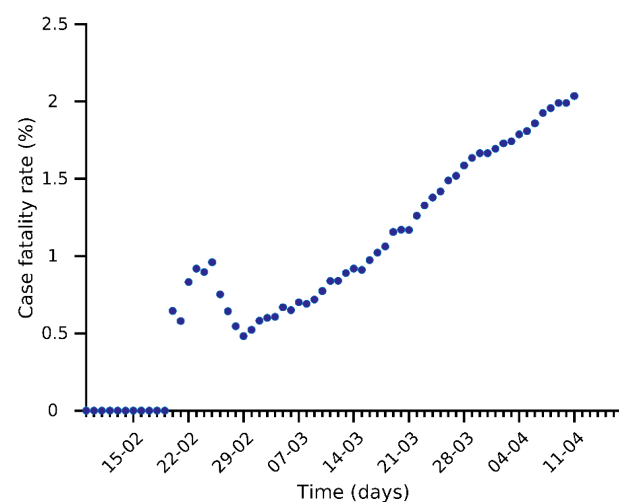
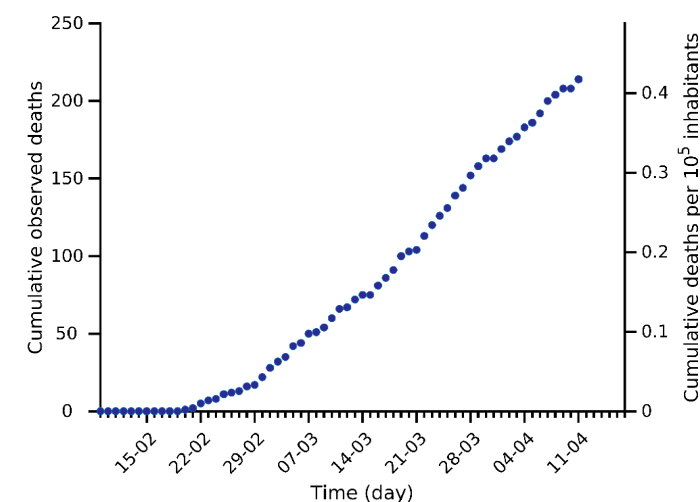
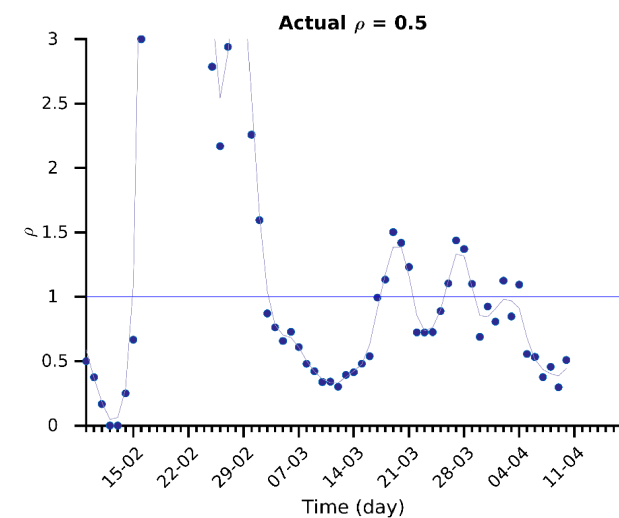
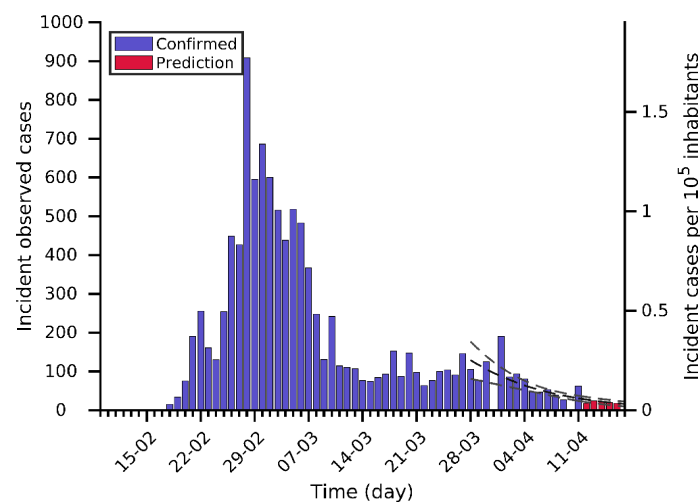
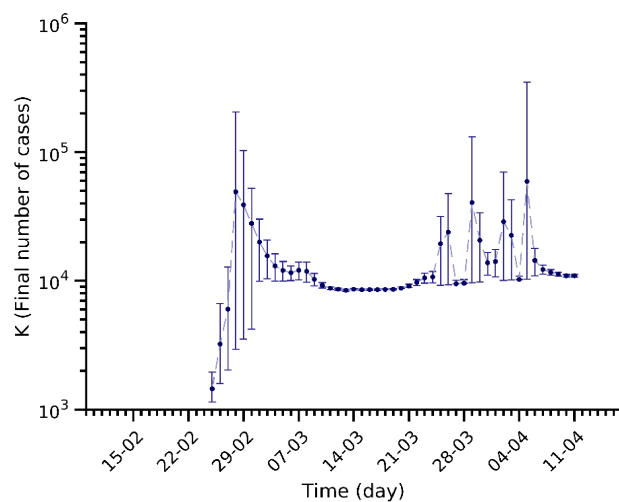
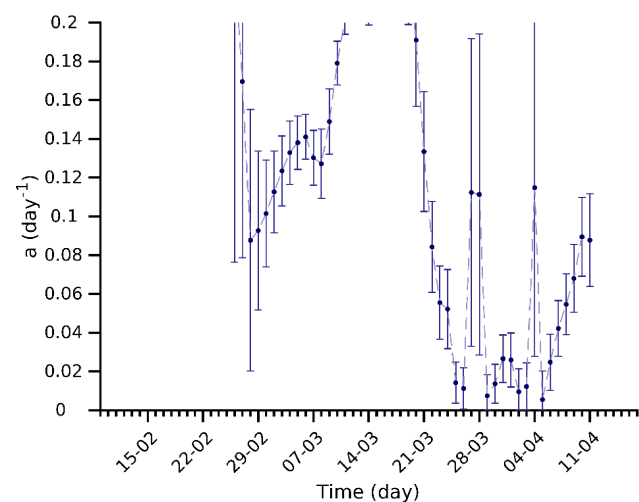
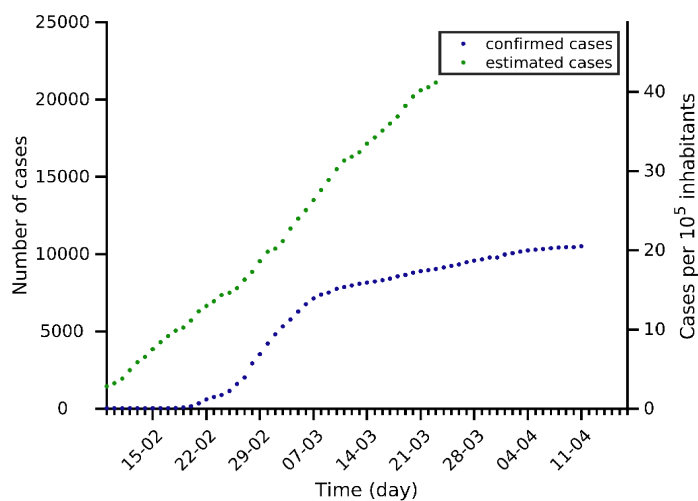
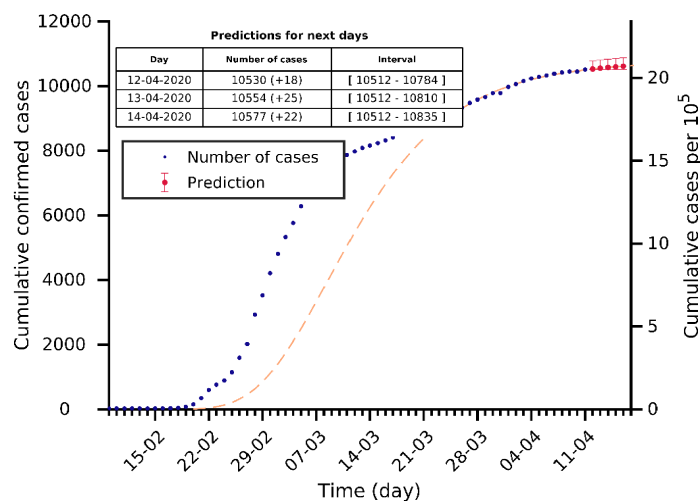
Canada 11-04-2020. Population: 37.7M. Current cumulated incidence: 62/10⁵



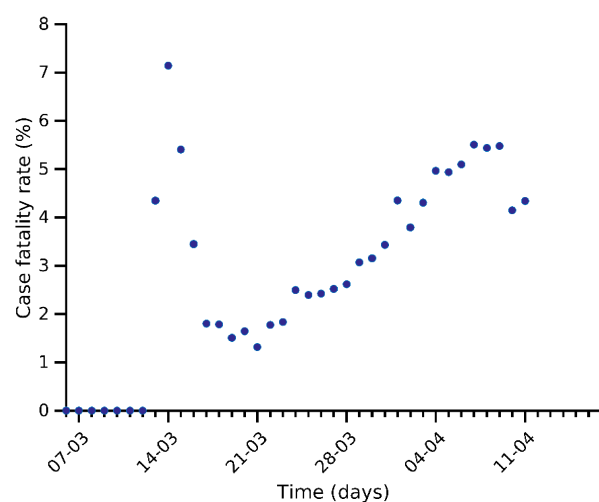
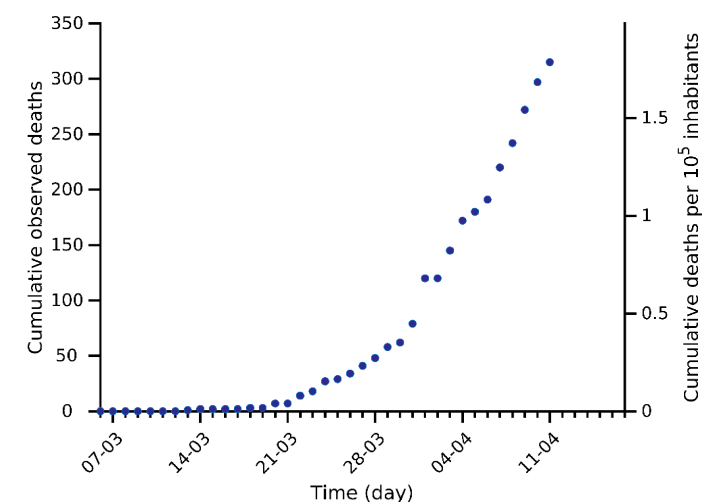
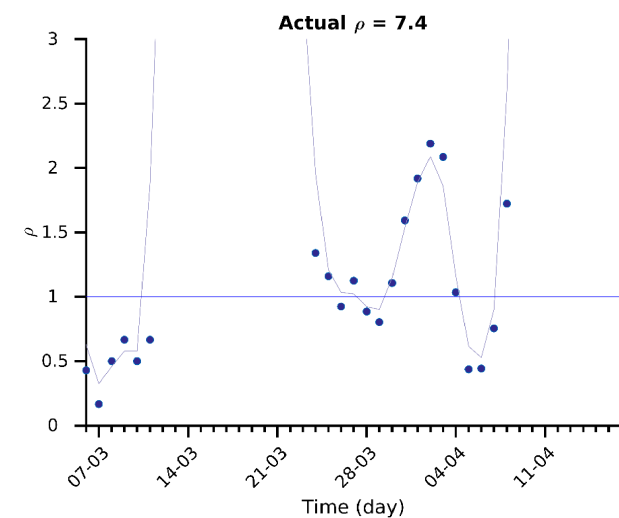
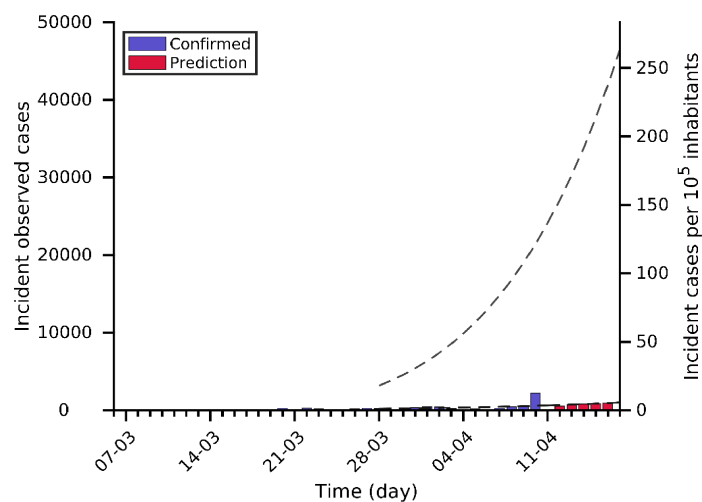
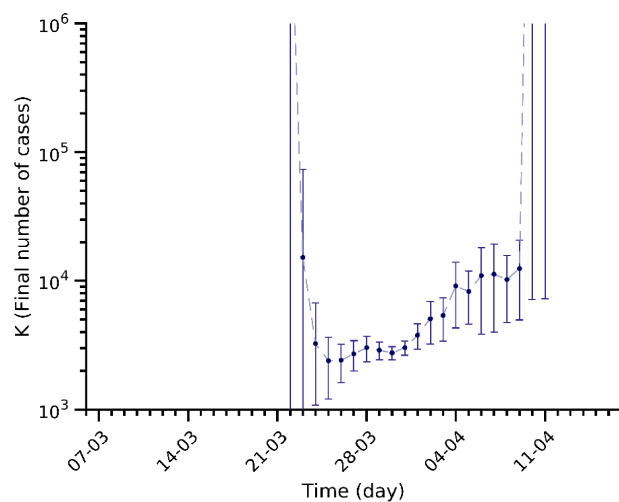
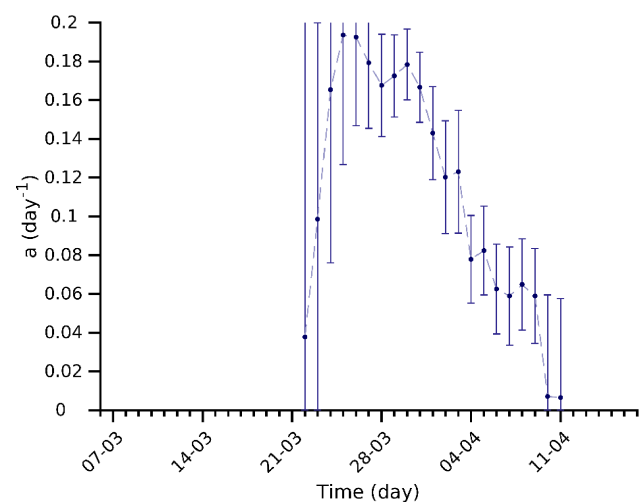
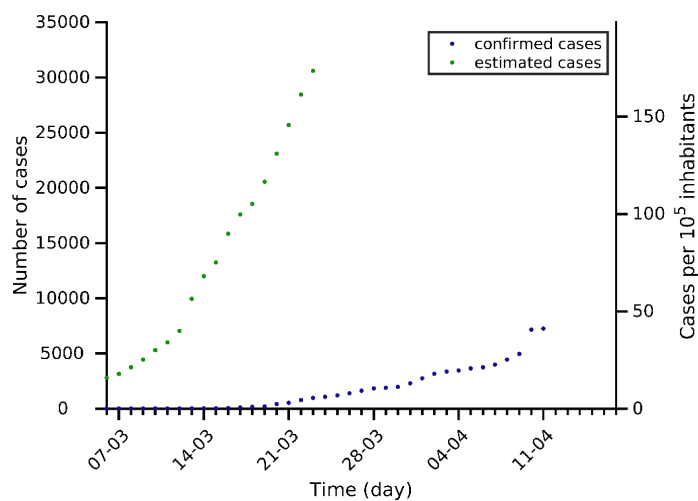
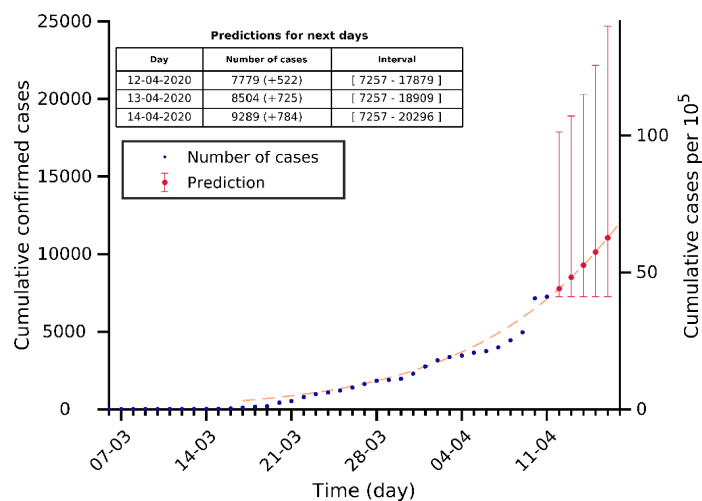
Brazil 11-04-2020. Population: 212.6M. Current cumulated incidence: 10/10⁵



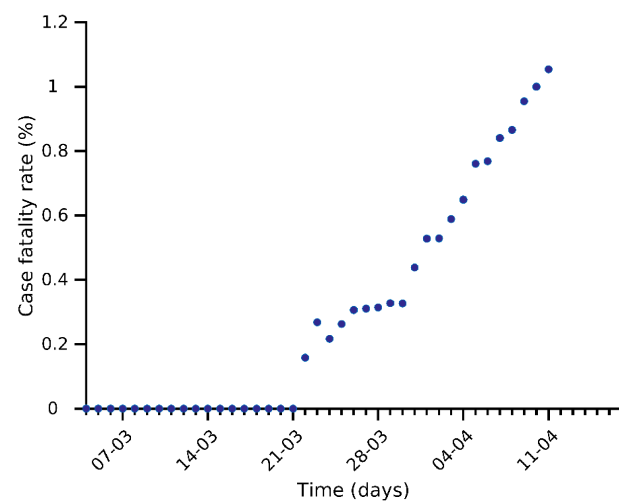
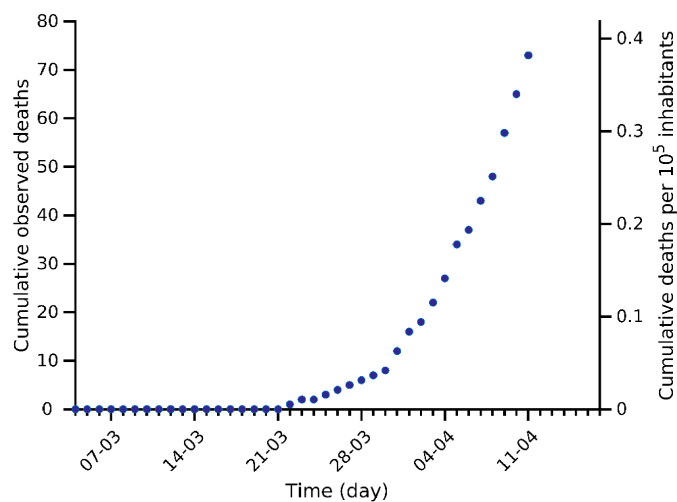
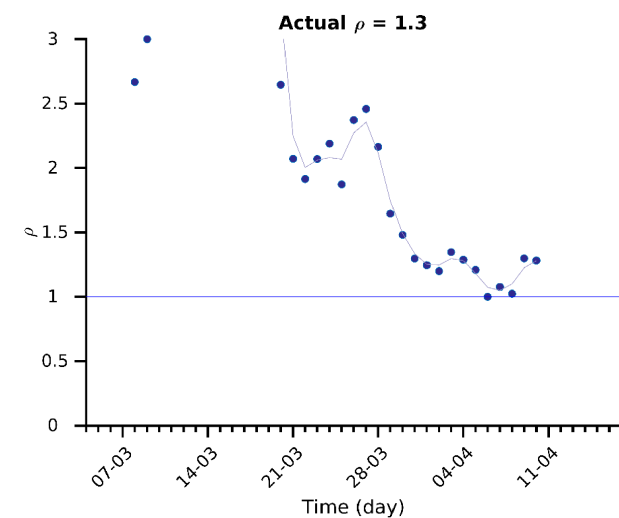
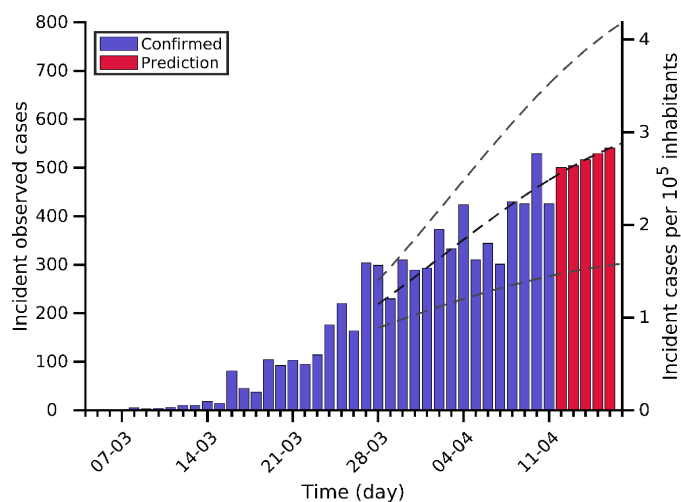
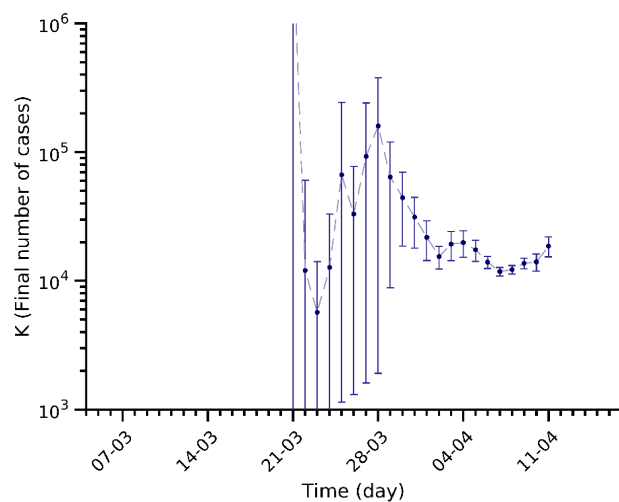
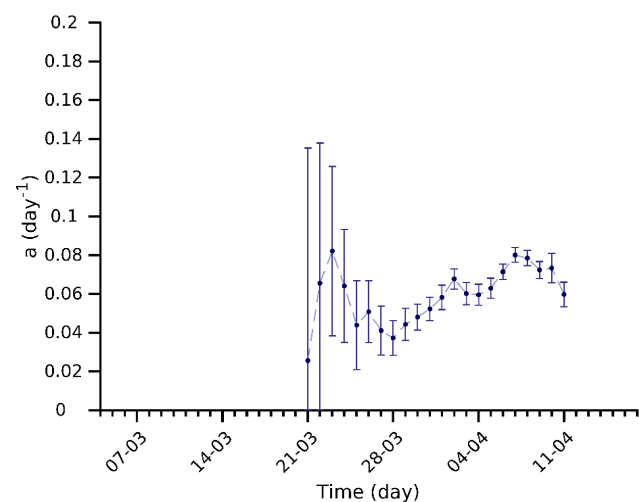
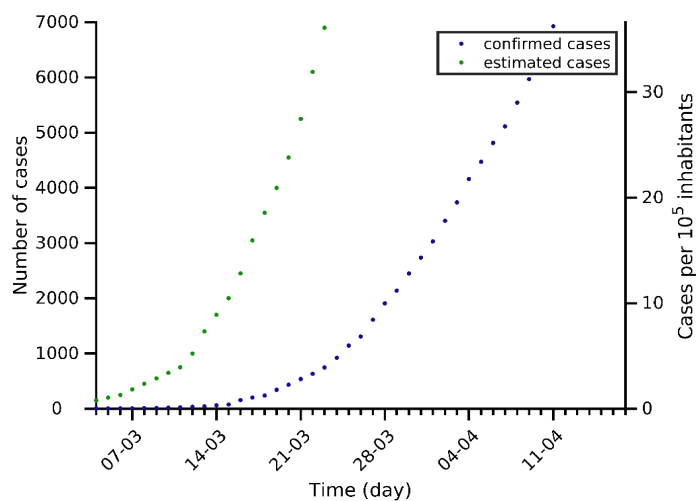
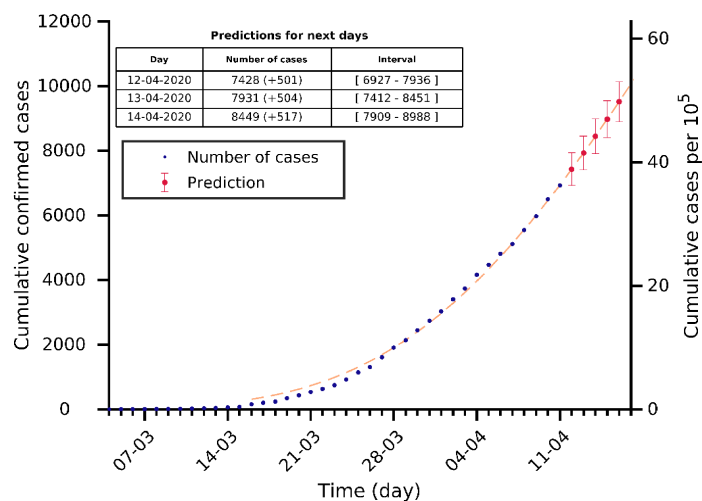
South Korea 11-04-2020. Population: 51.3M. Current cumulated incidence: 21/10⁵



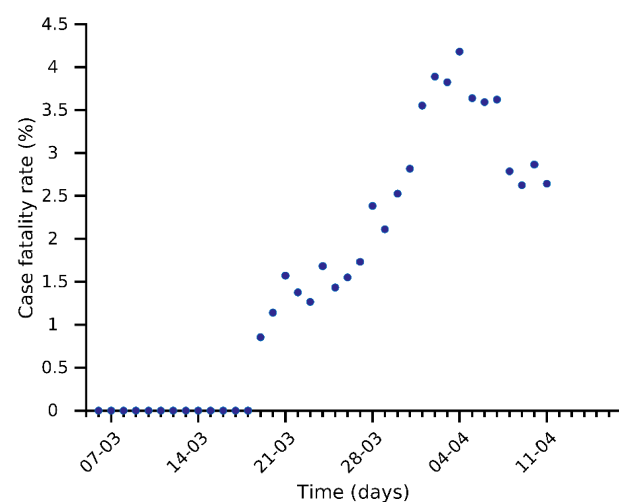
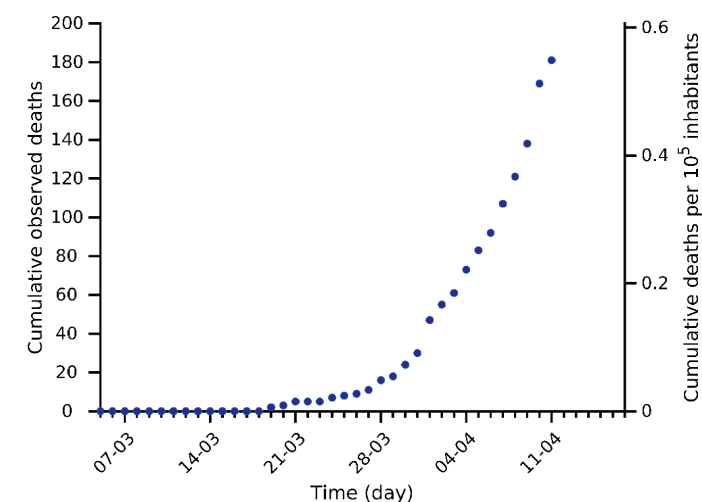
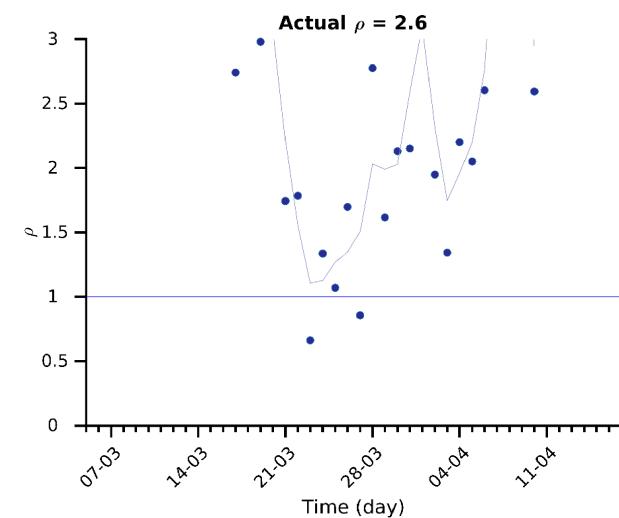
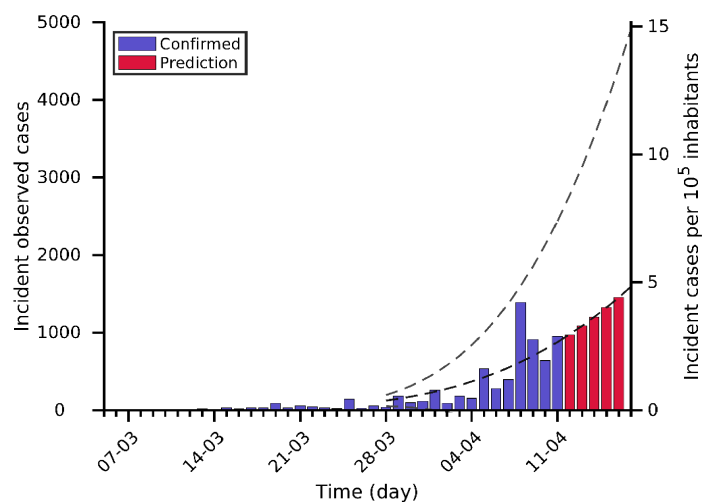
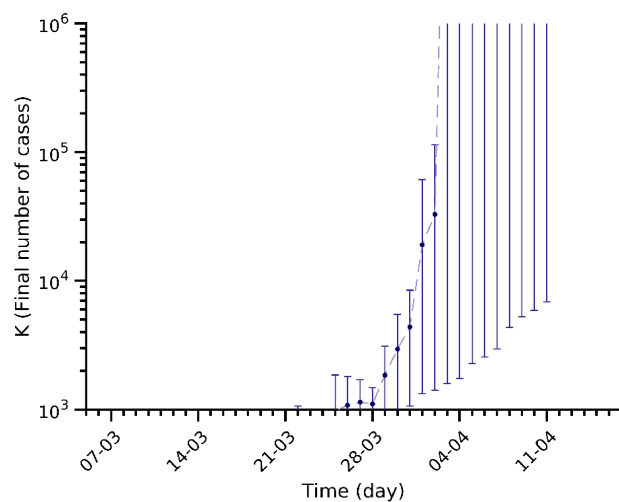
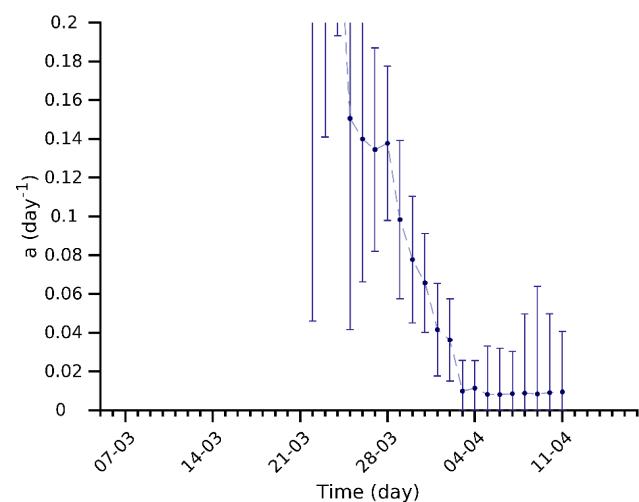
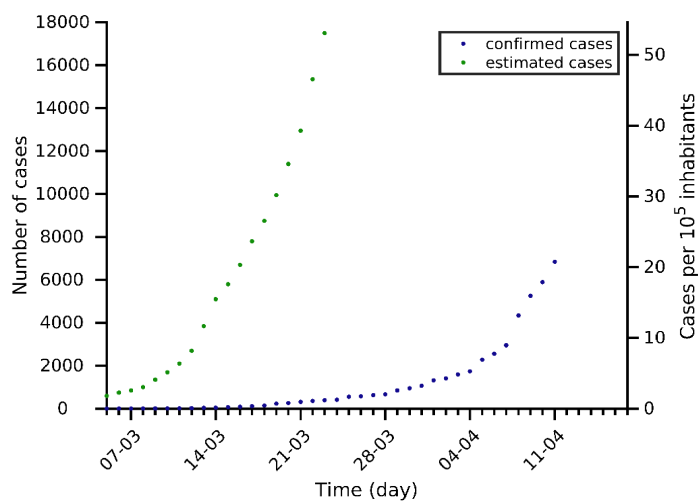
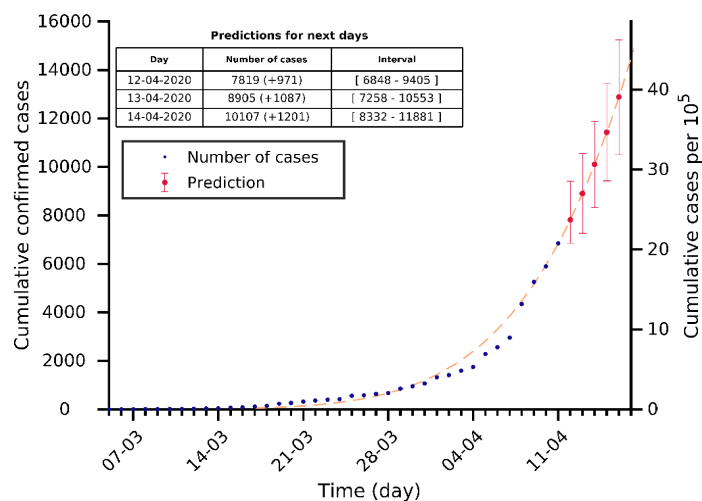
Ecuador 11-04-2020. Population: 17.6M. Current cumulated incidence: 41/10⁵



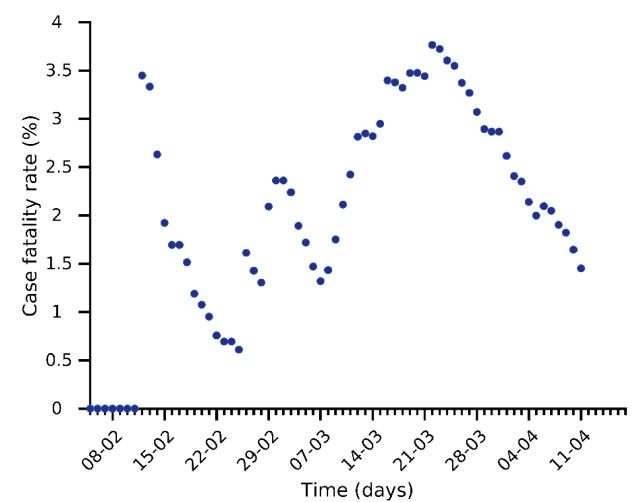
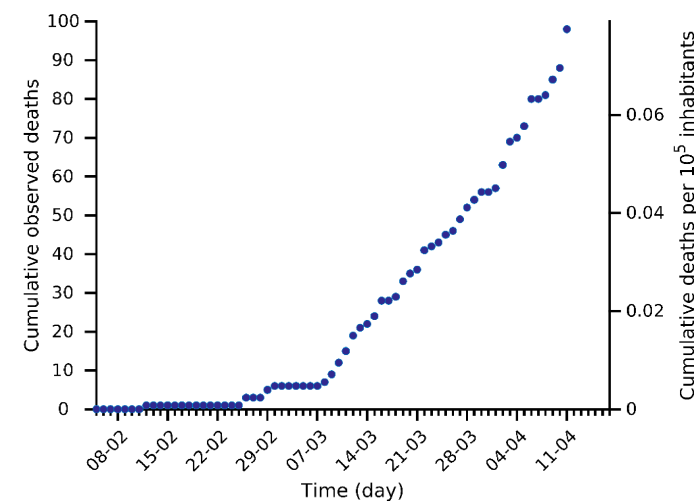
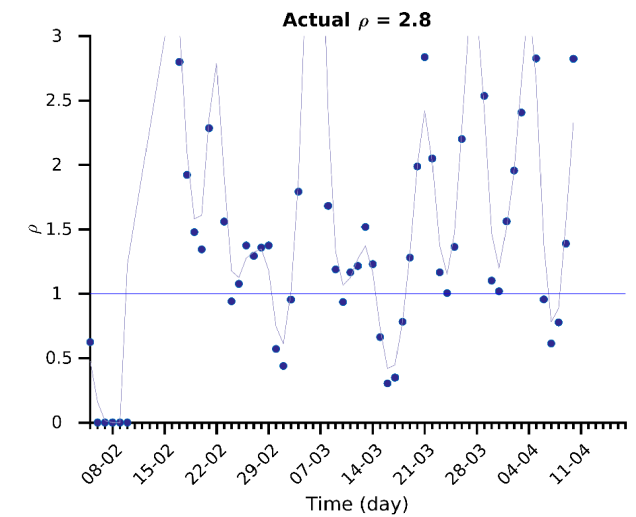
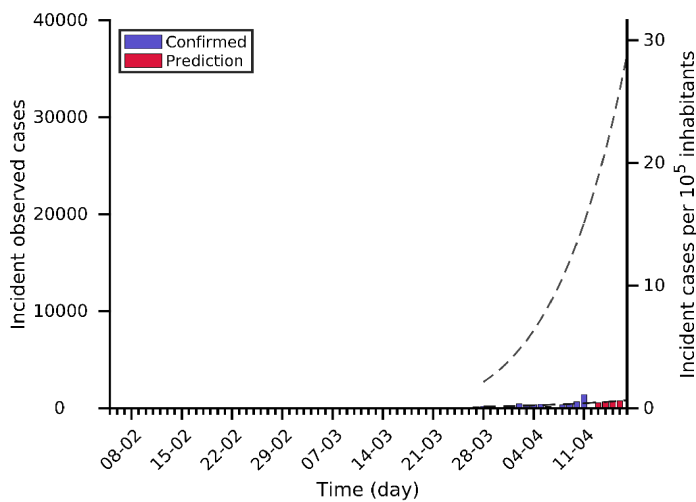
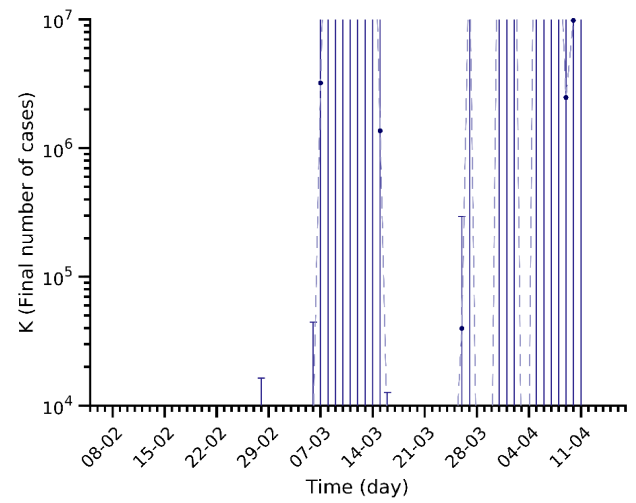
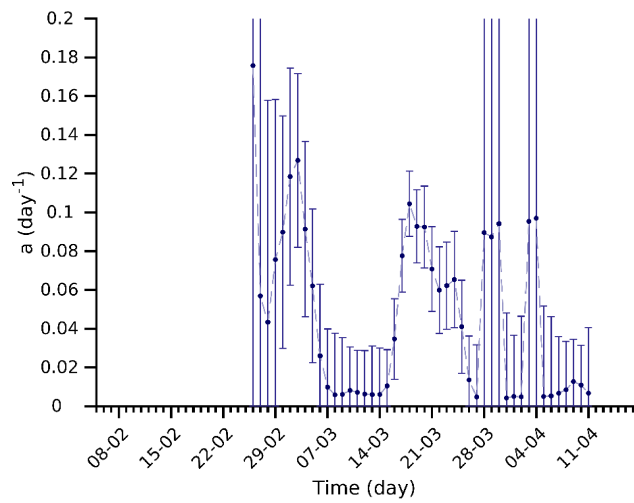
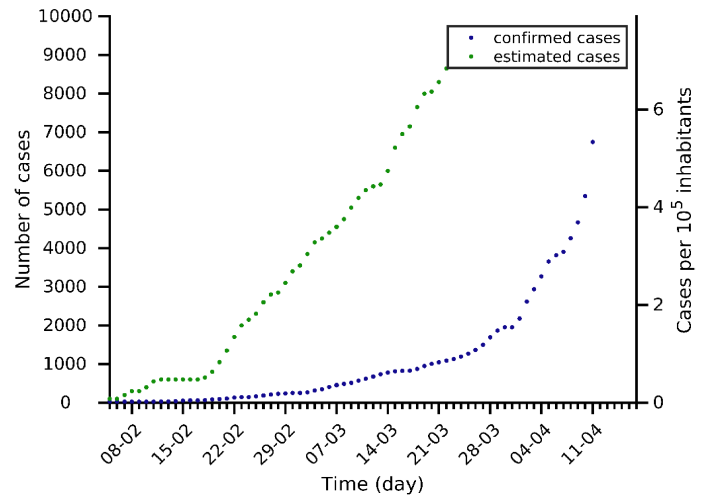
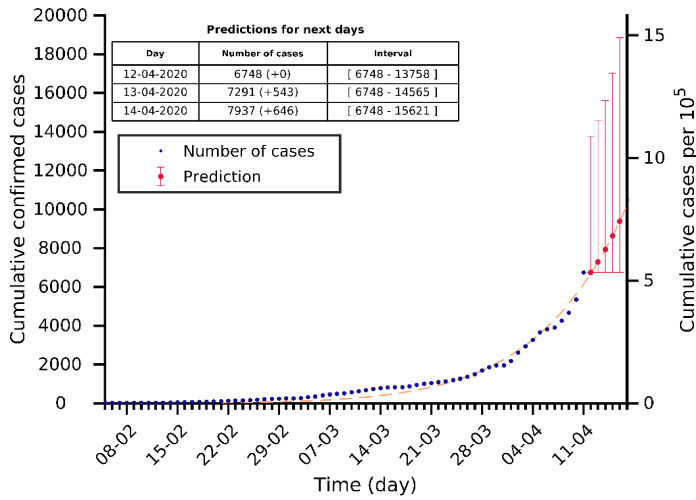
Chile 11-04-2020. Population: 19.1M. Current cumulated incidence: 36/10⁵



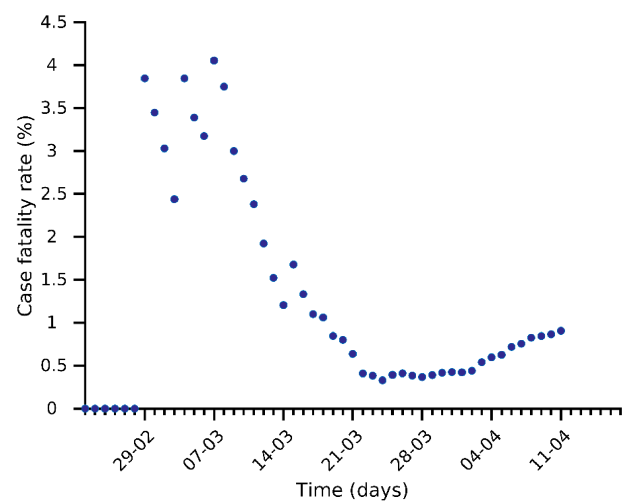
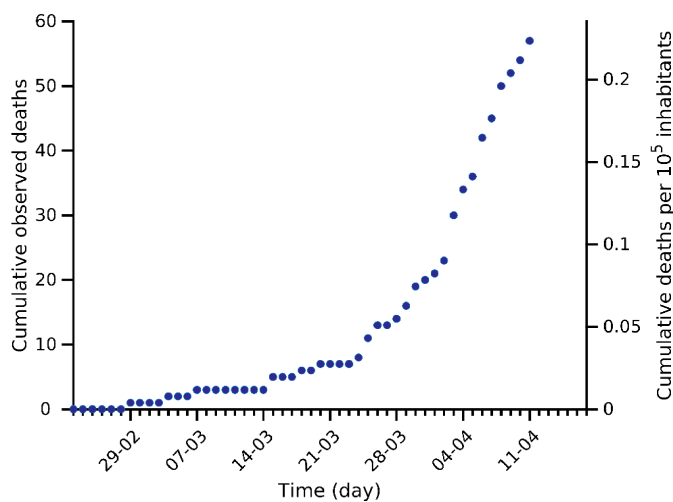
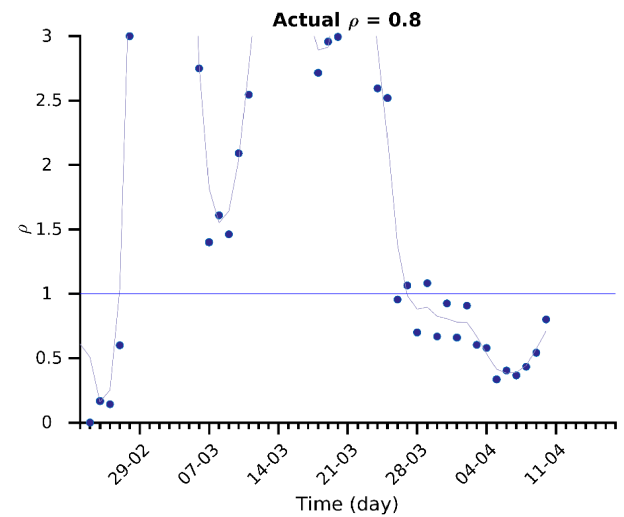
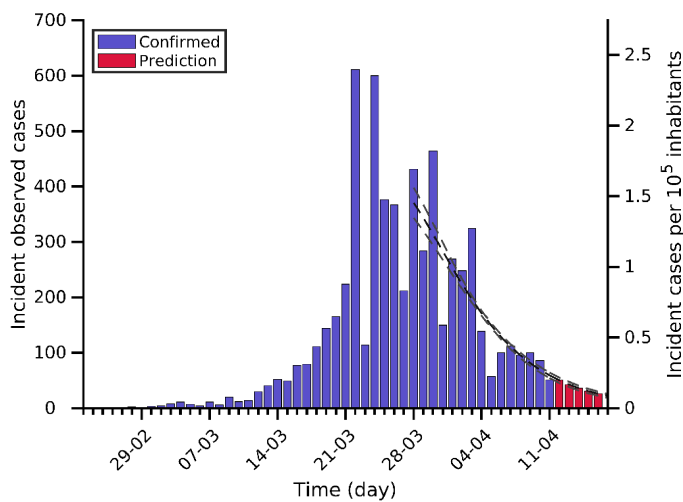
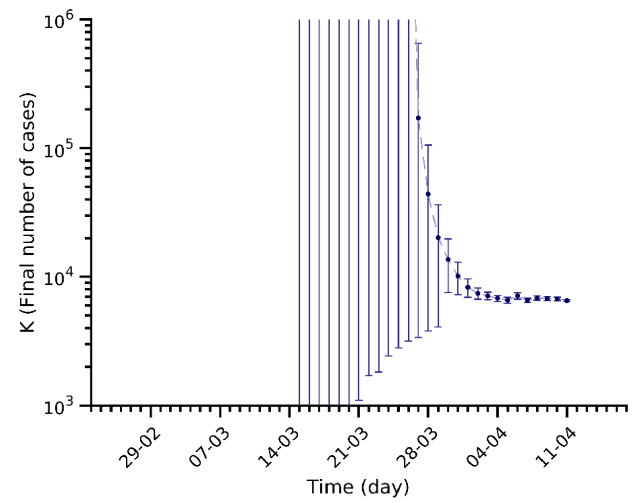
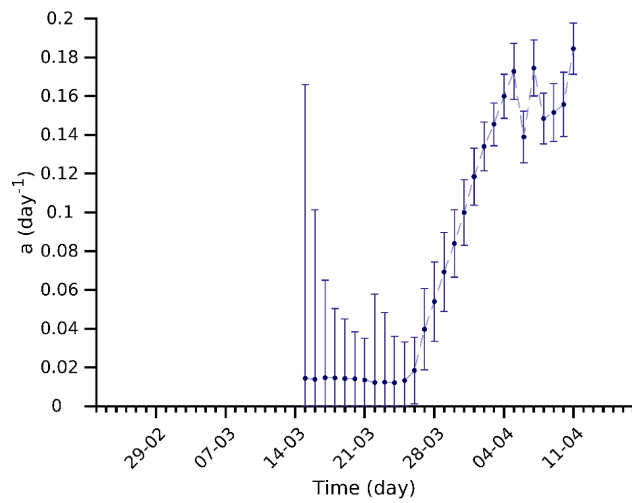
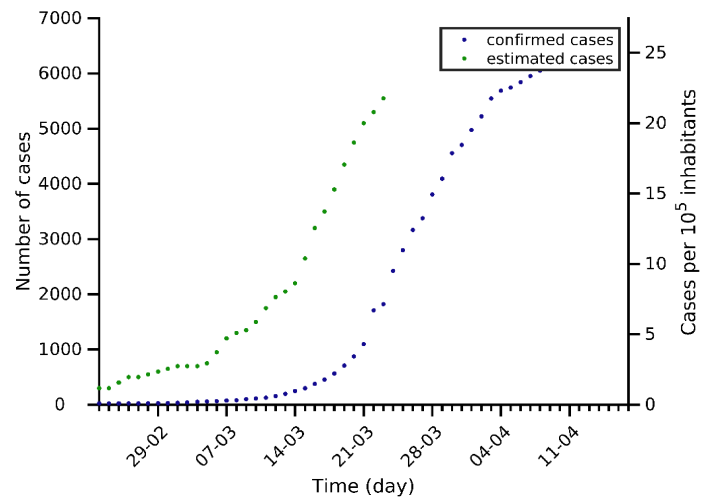
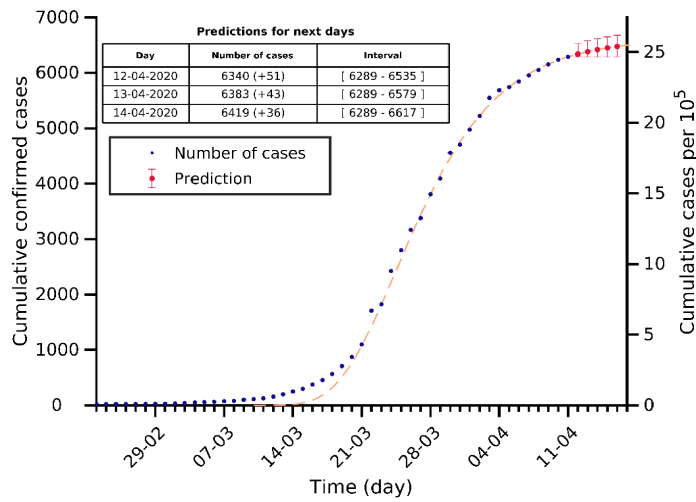
Peru 11-04-2020. Population: 33.0M. Current cumulated incidence: 21/10⁵



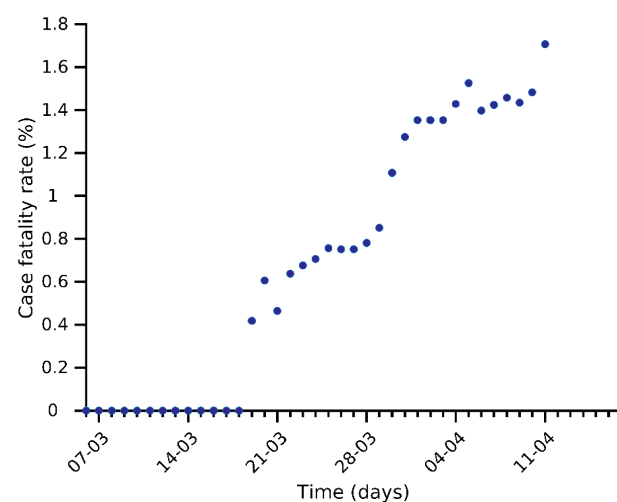
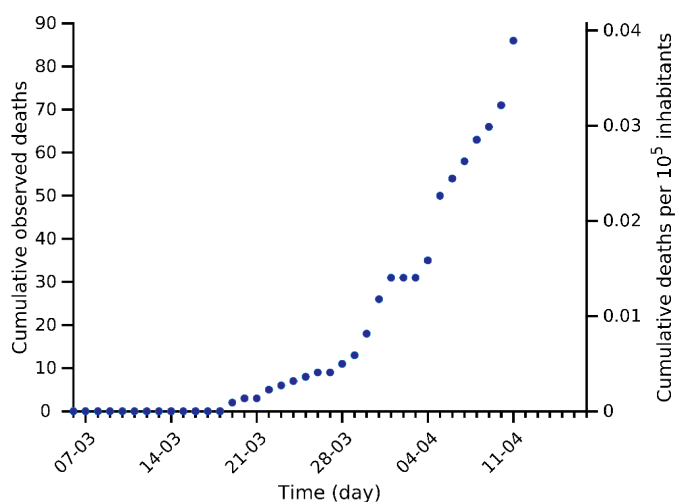
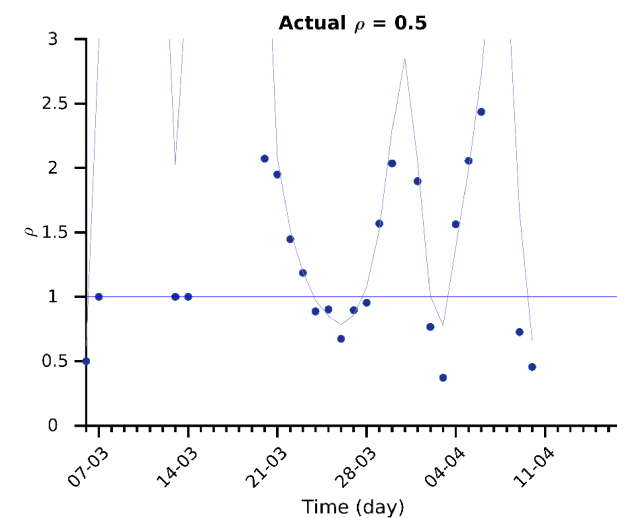
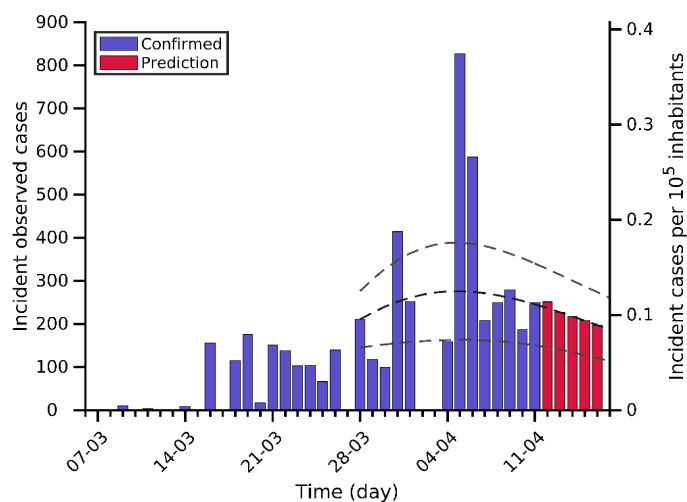
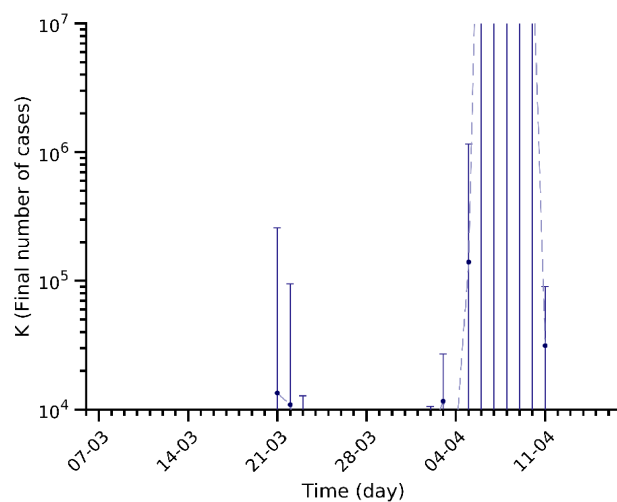
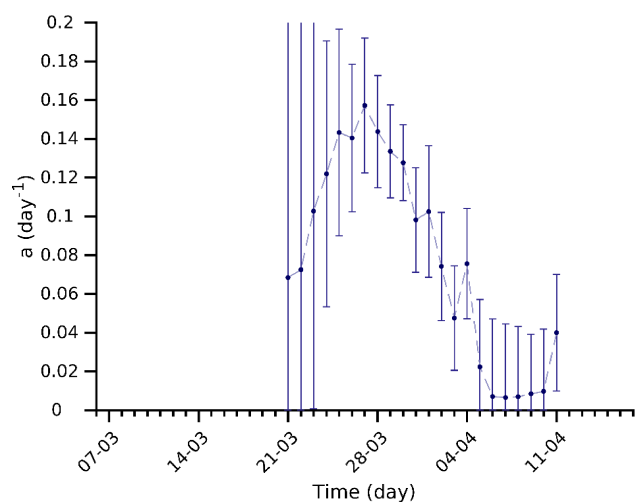
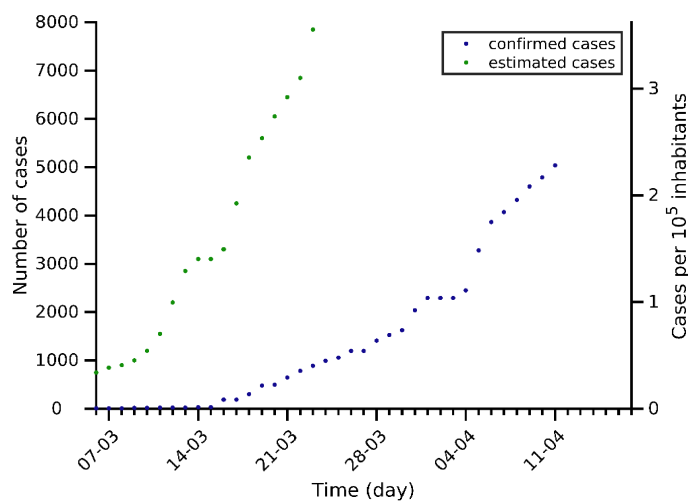
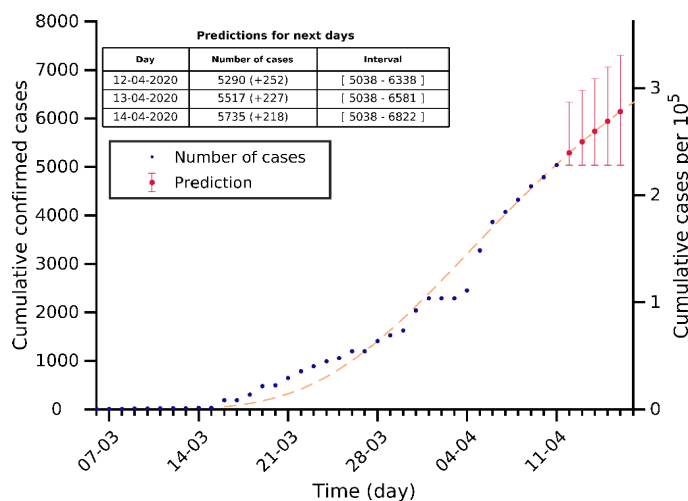
Japan 11-04-2020. Population: 126.5M. Current cumulated incidence: $5/10^5$



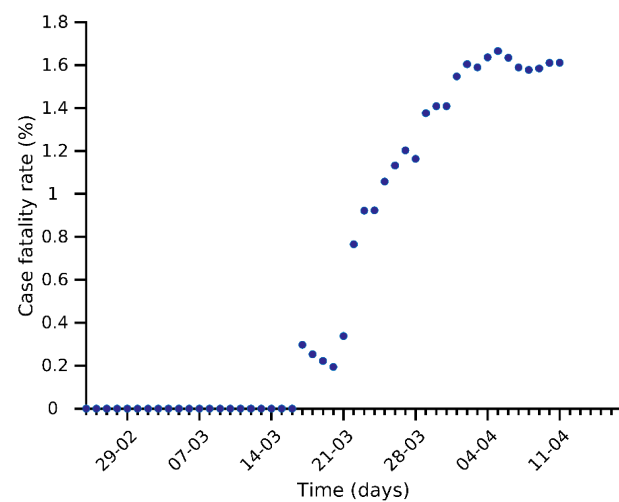
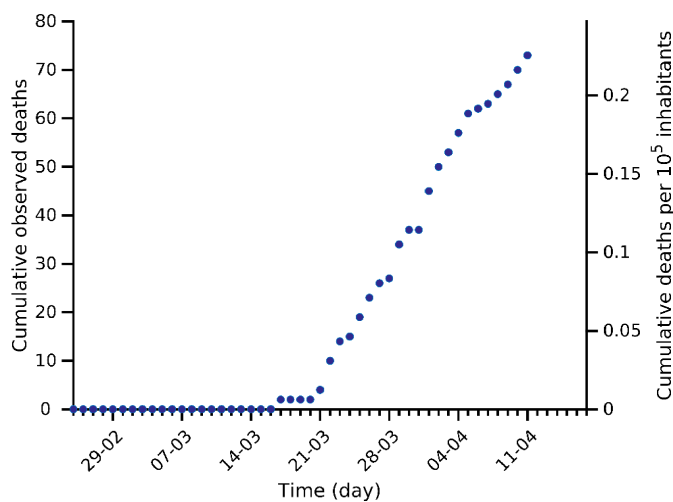
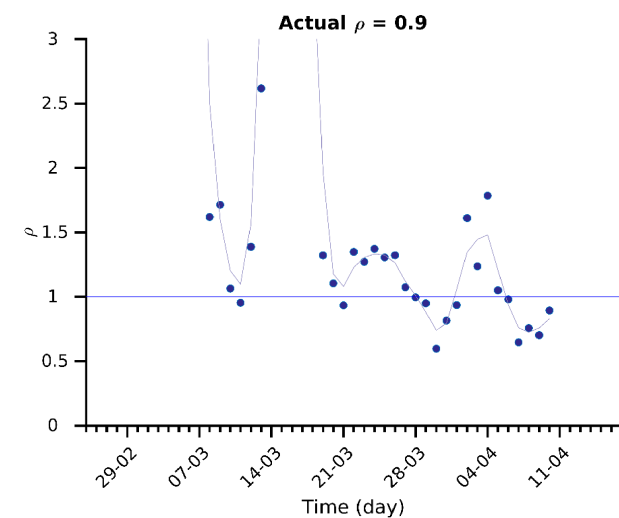
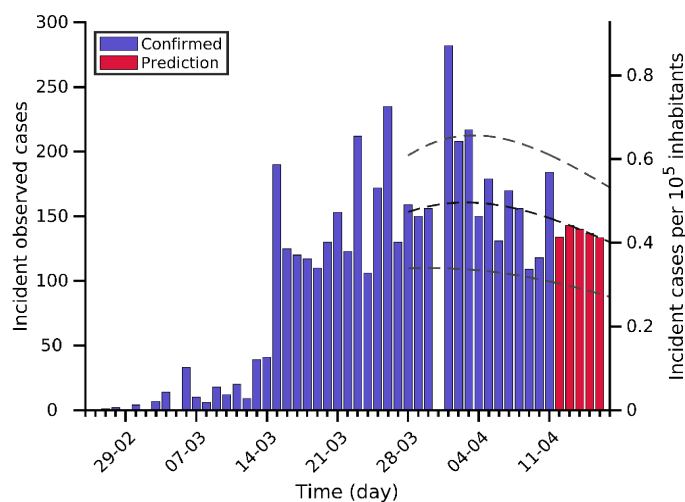
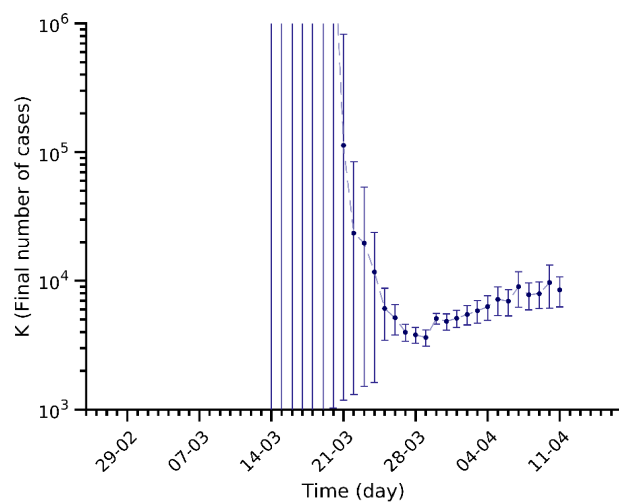
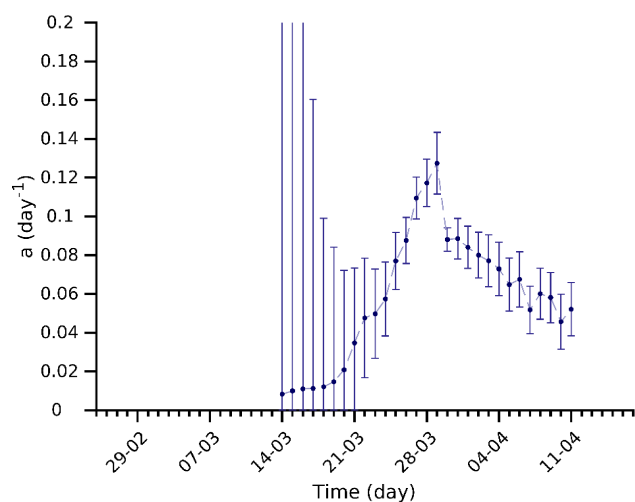
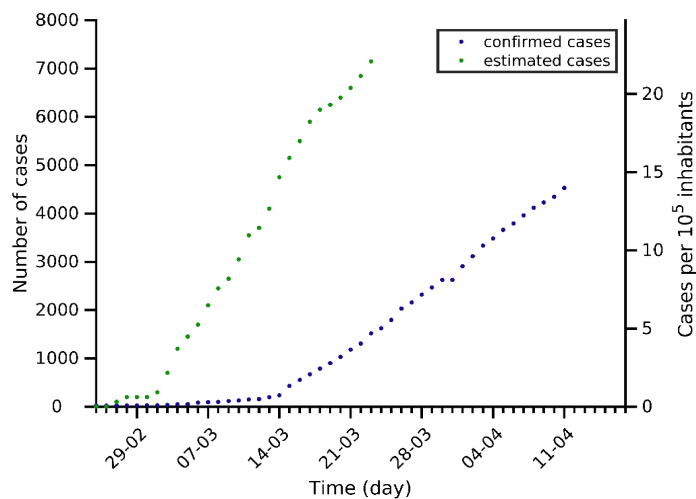
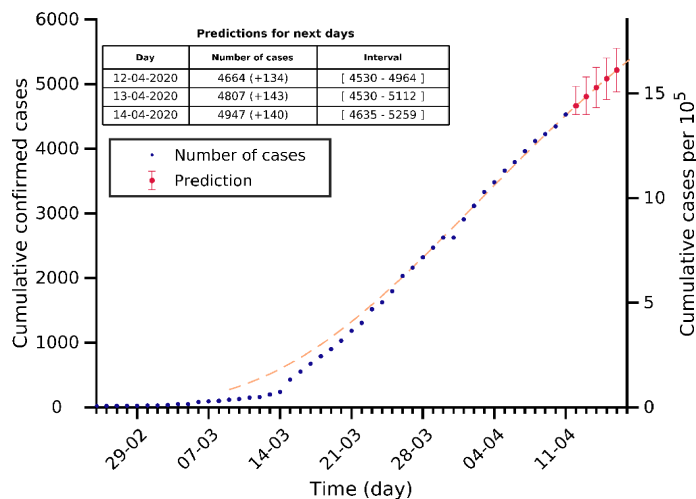
Australia 11-04-2020. Population: 25.5M. Current cumulated incidence: 25/10⁵



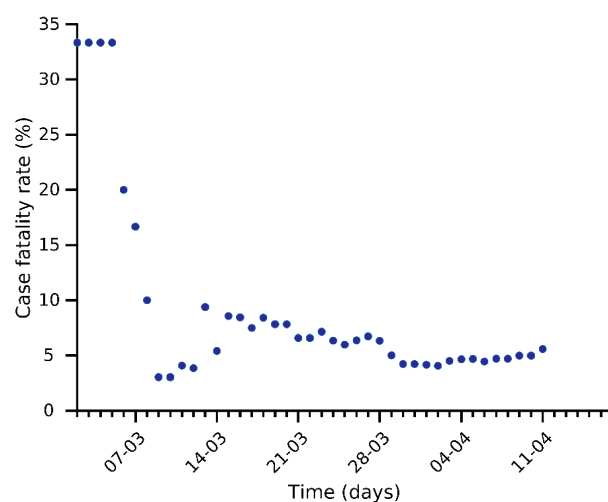
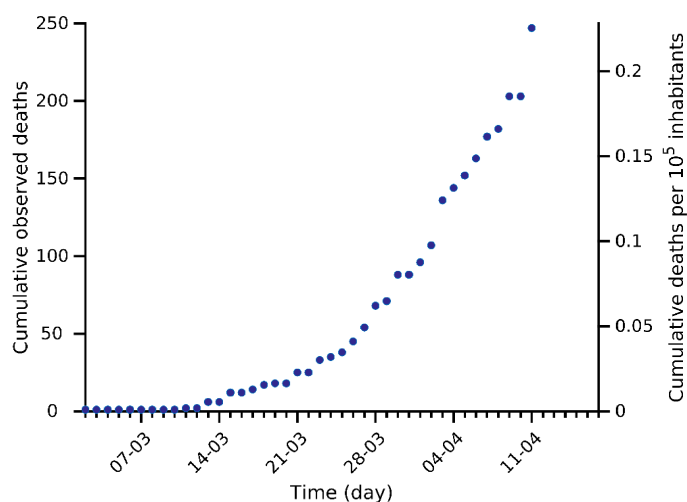
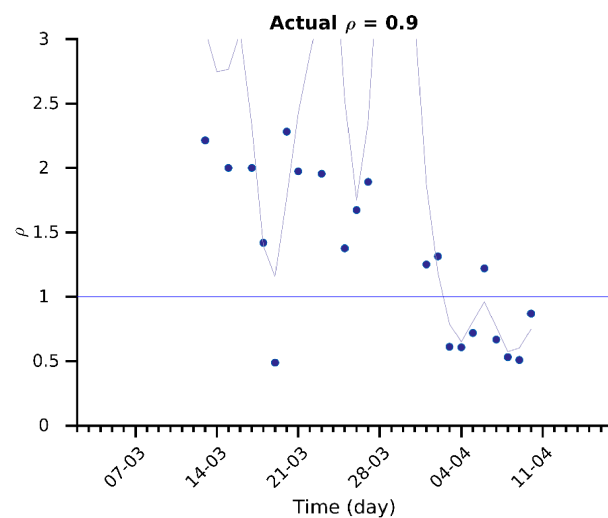
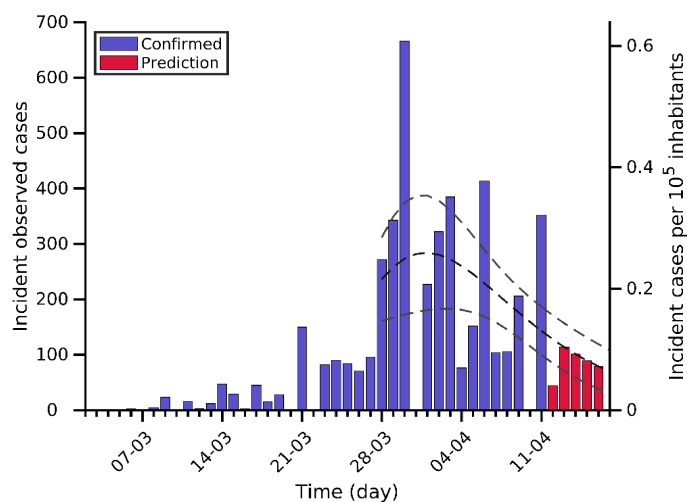
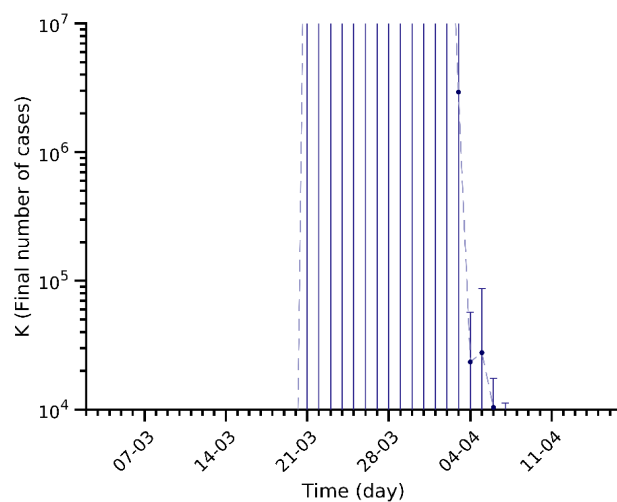
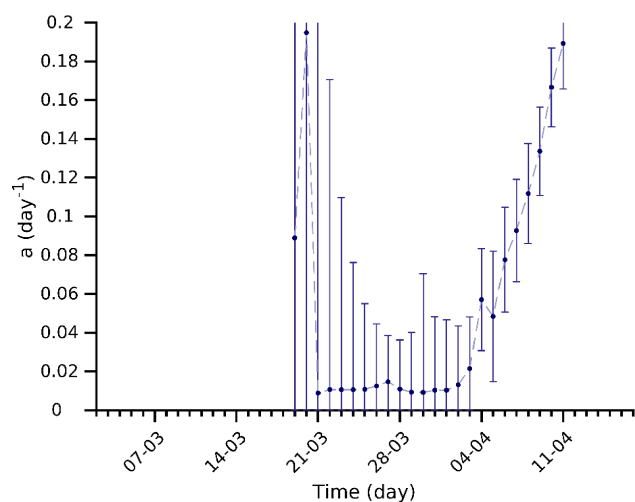
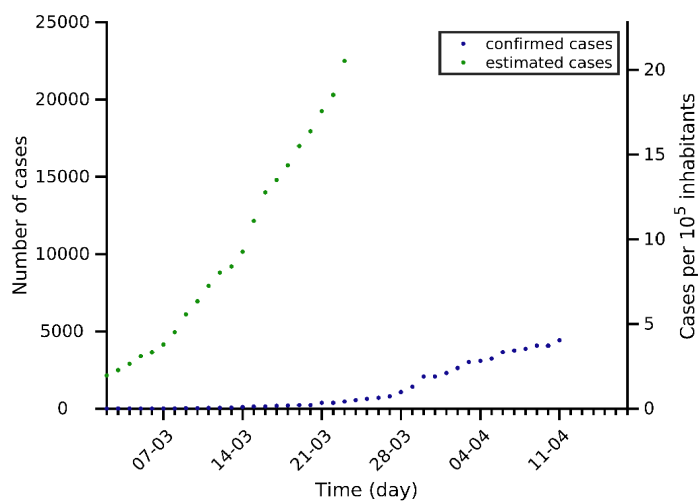
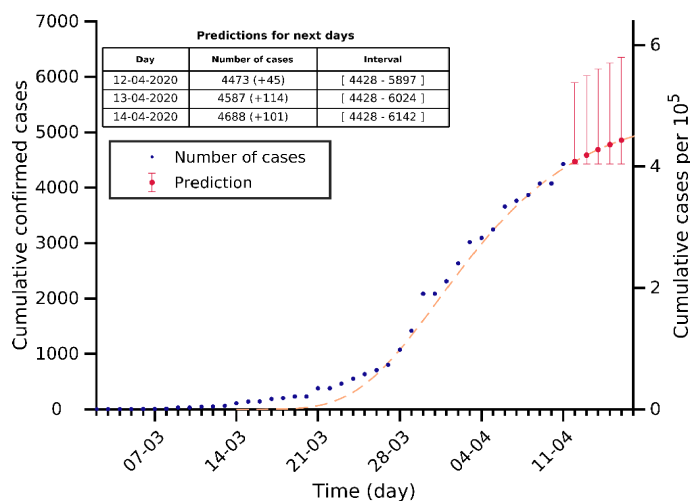
Pakistan 11-04-2020. Population: 220.9M. Current cumulated incidence: $2/10^5$



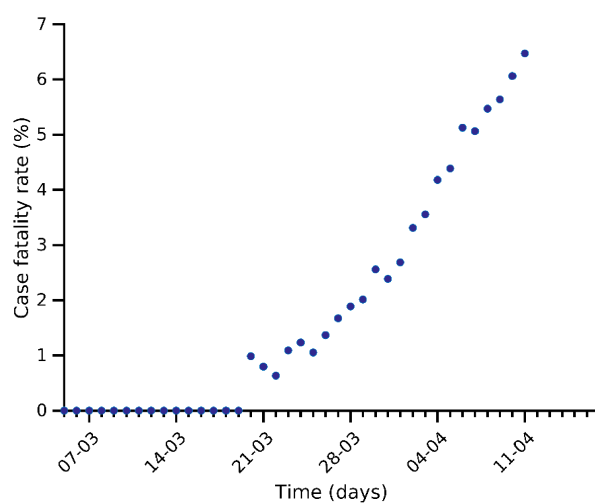
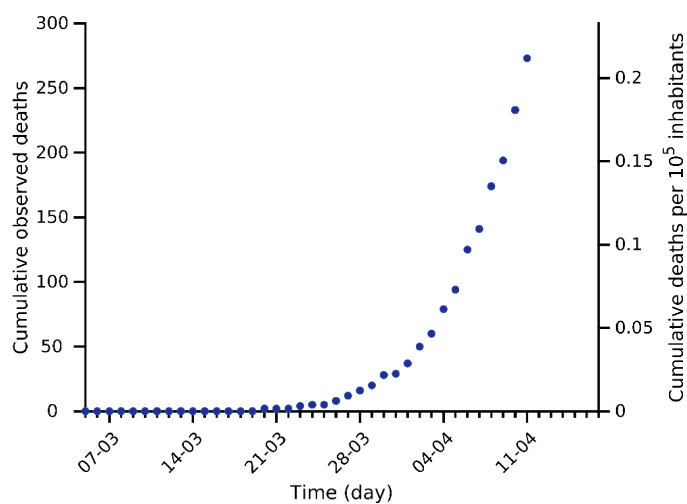
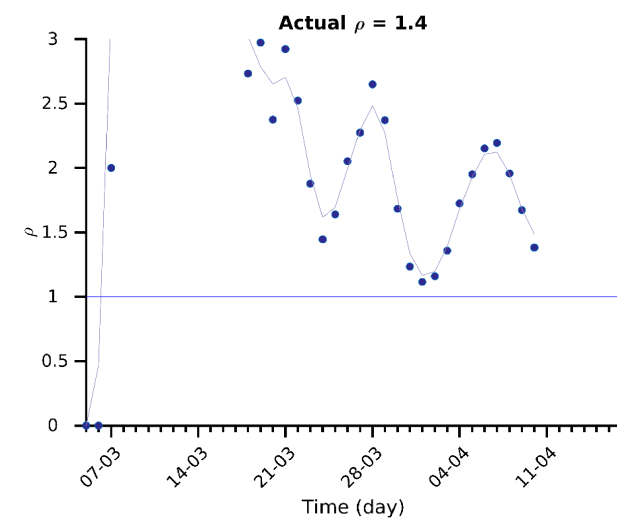
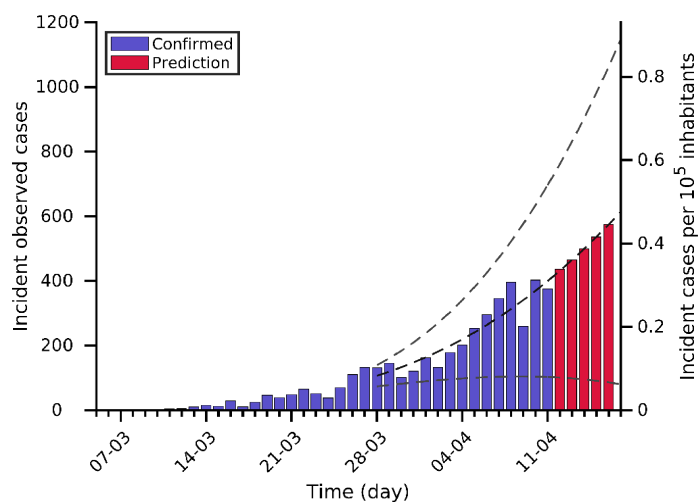
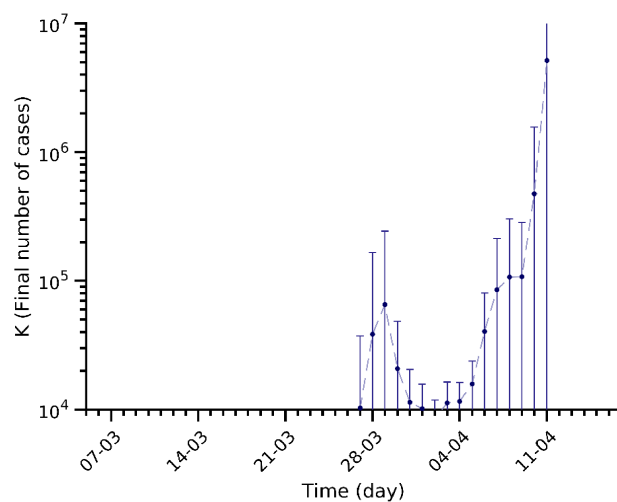
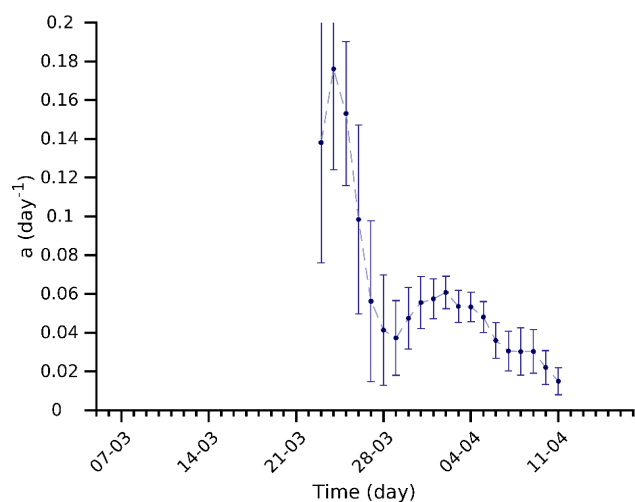
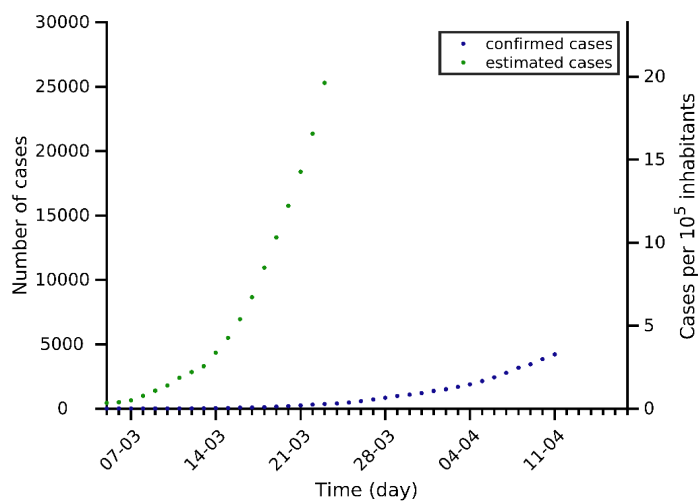
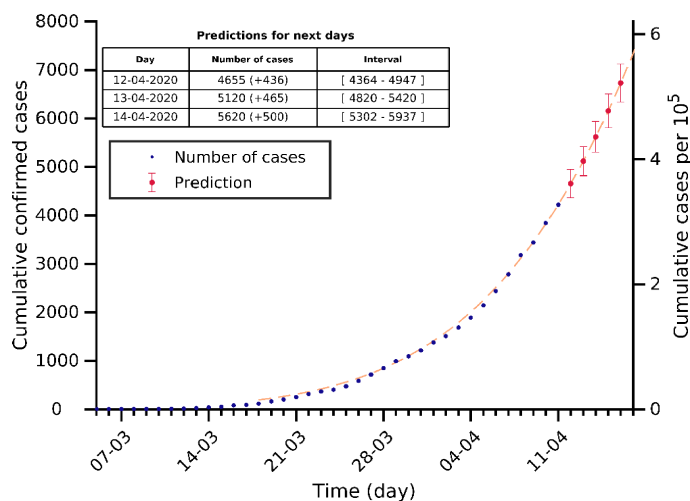
Malaysia 11-04-2020. Population: 32.4M. Current cumulated incidence: 14/10⁵



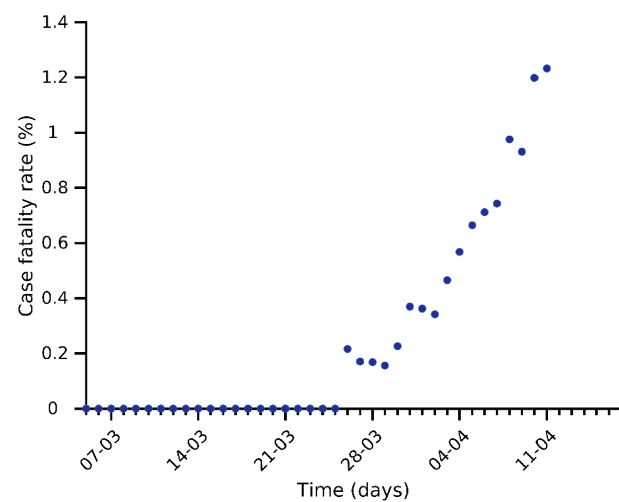
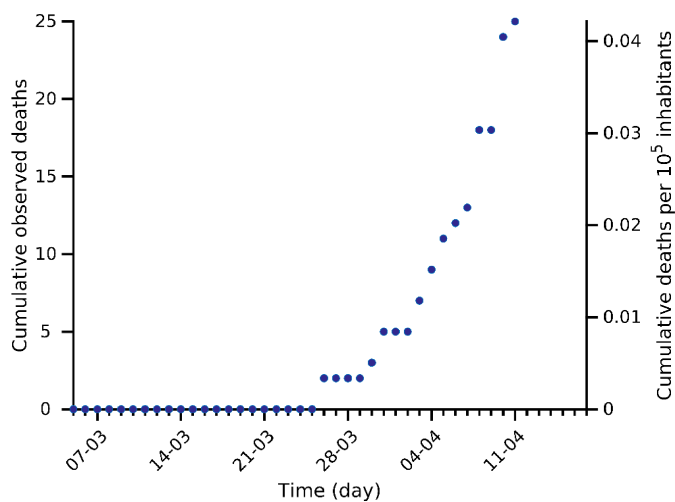
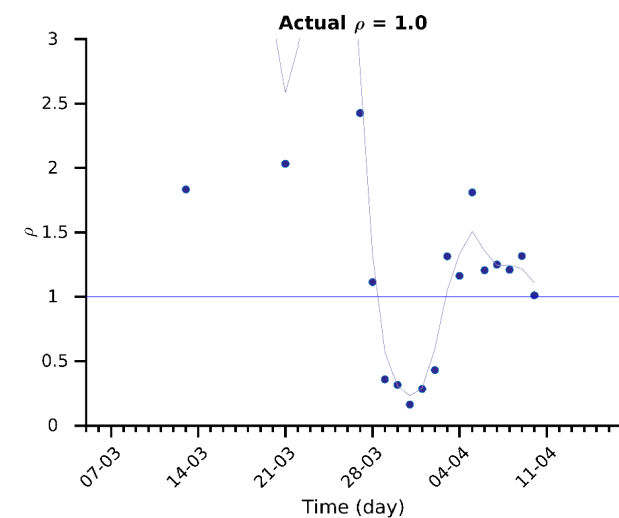
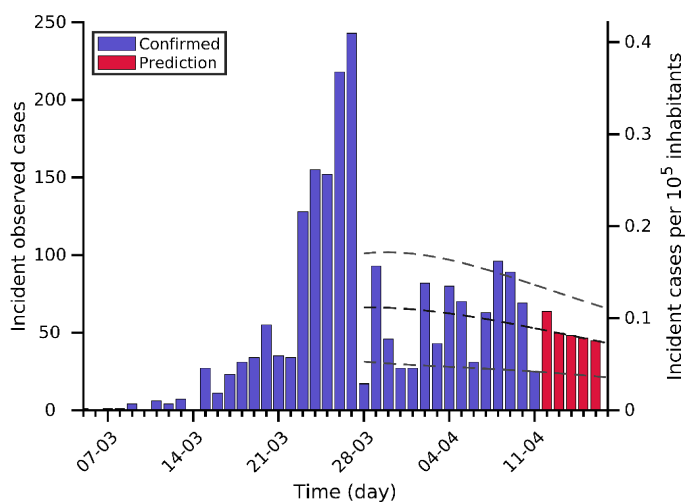
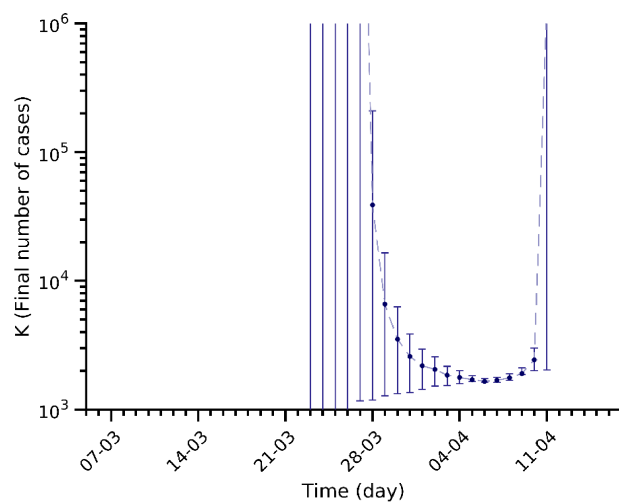
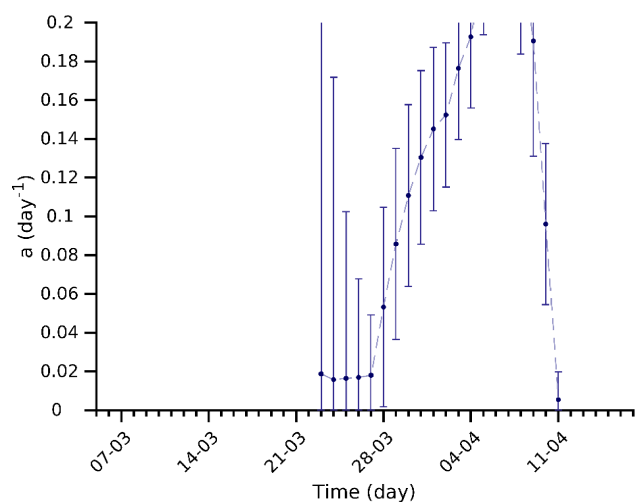
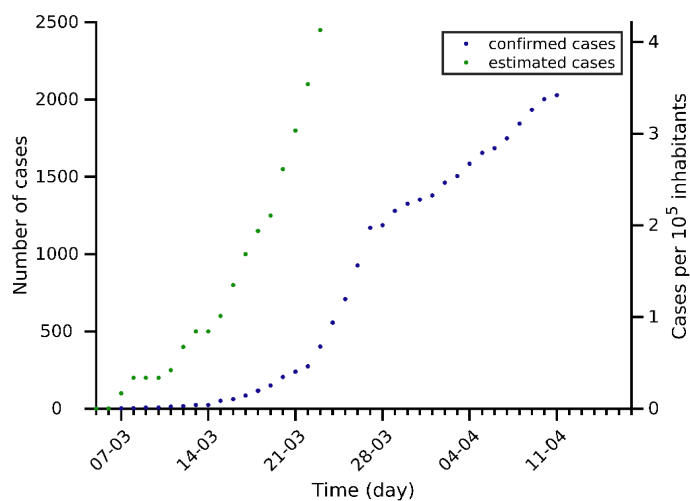
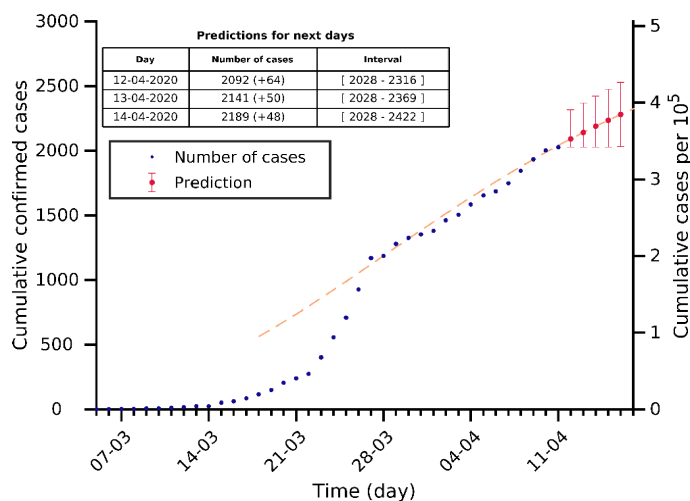
Philippines 11-04-2020. Population: 109.6M. Current cumulated incidence: 4/10⁵



Mexico 11-04-2020. Population: 128.9M. Current cumulated incidence: $3/10^5$



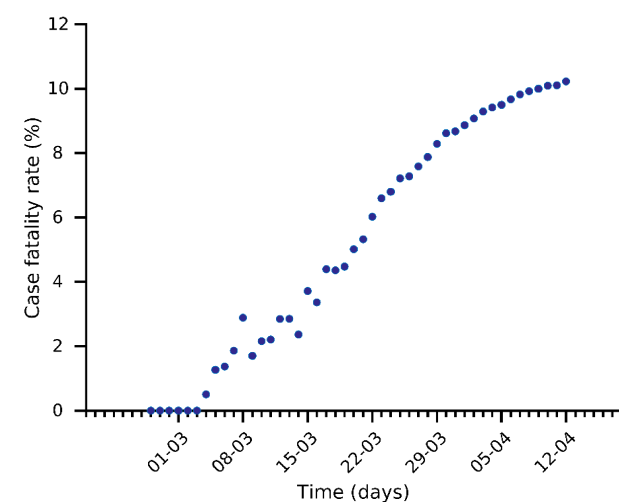
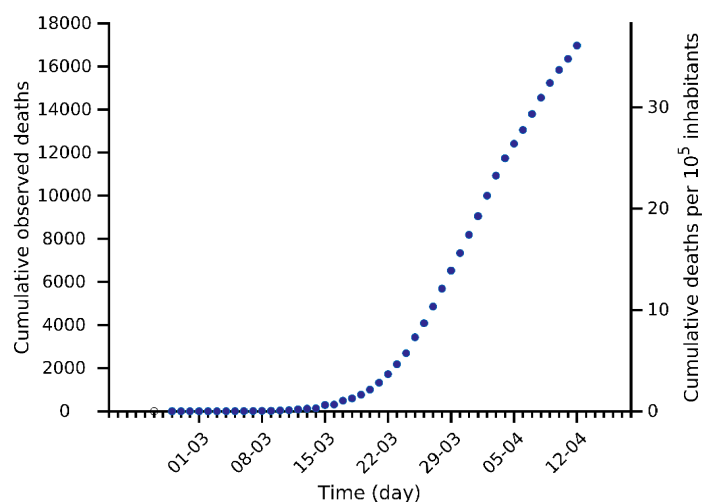
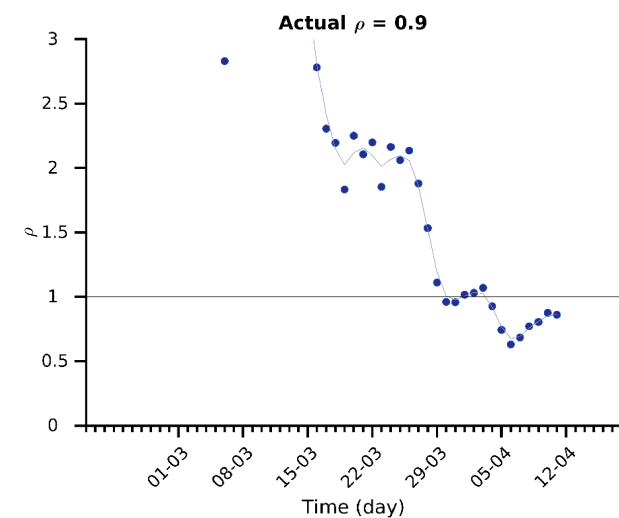
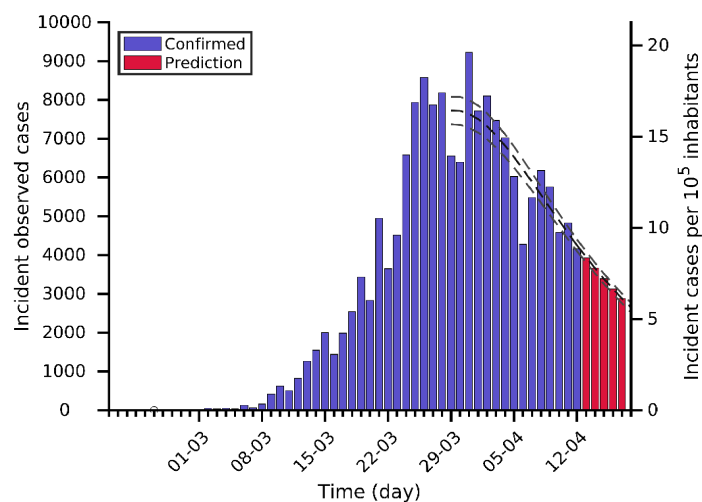
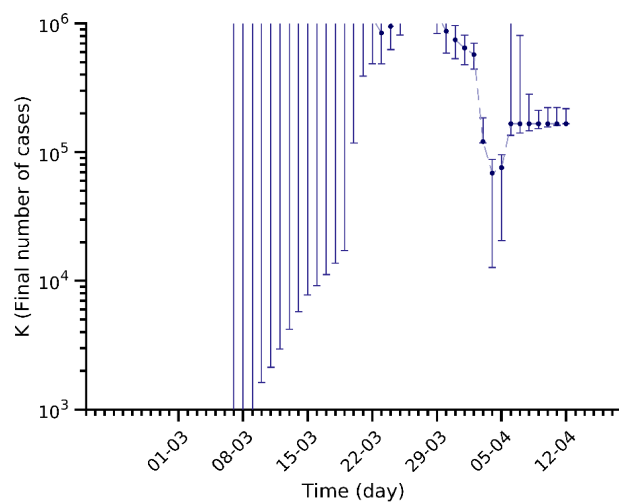
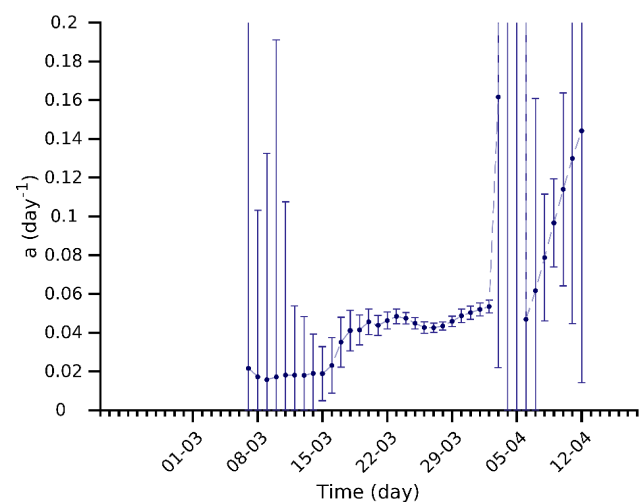
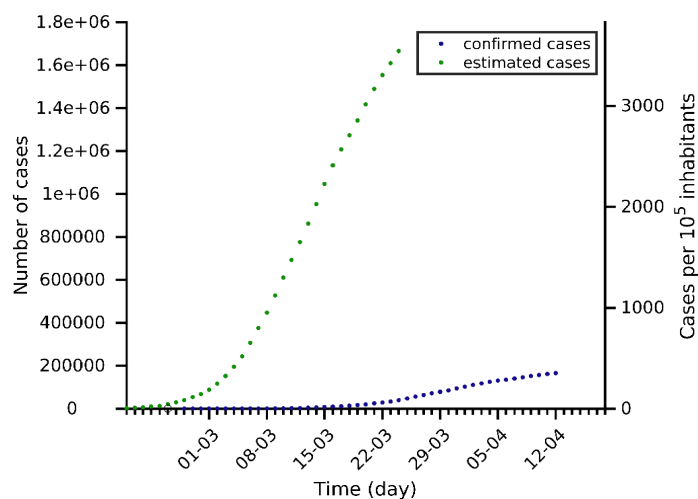
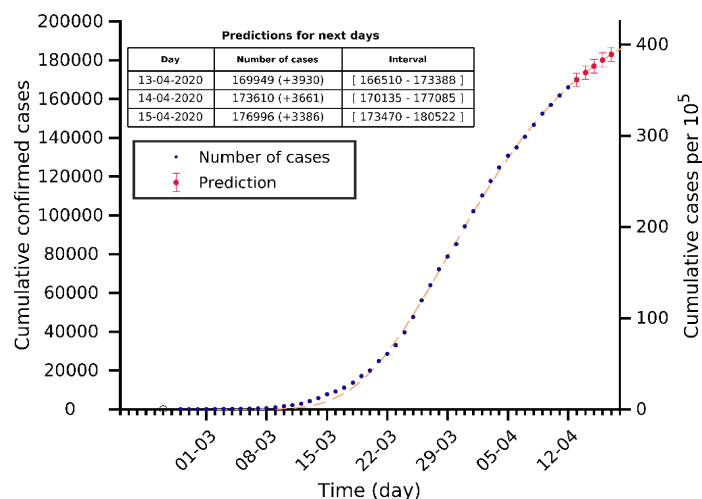
South Africa 11-04-2020. Population: 59.3M. Current cumulated incidence: $3/10^5$



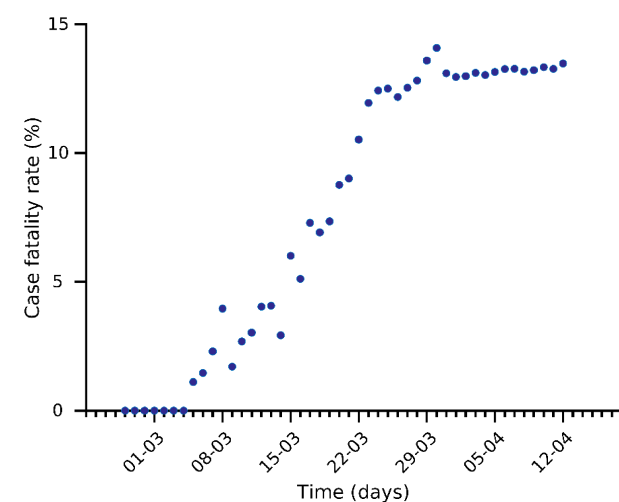
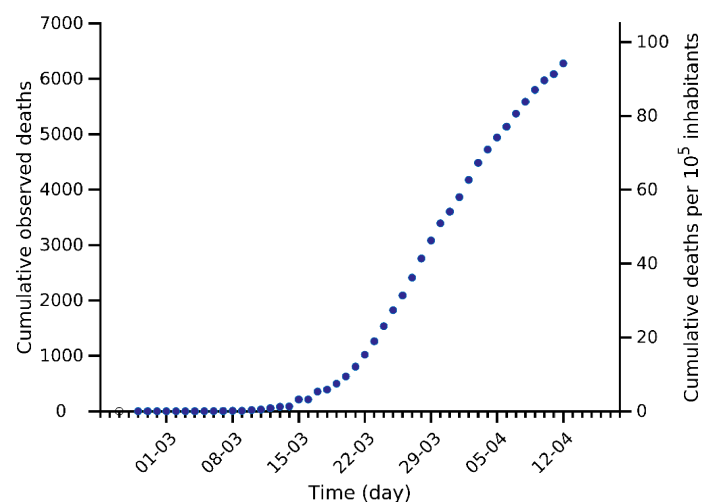
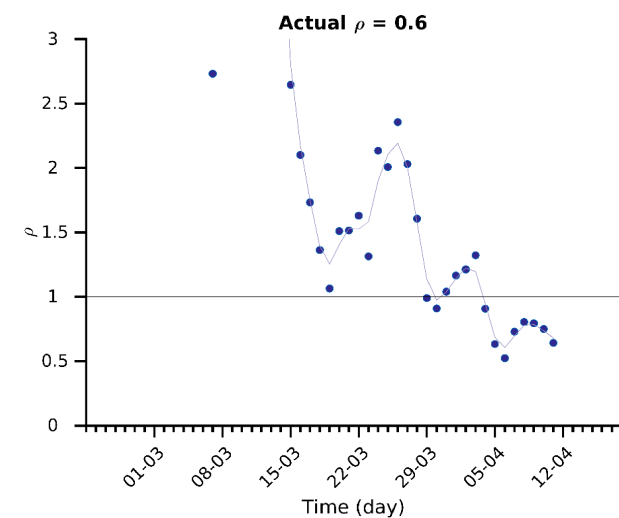
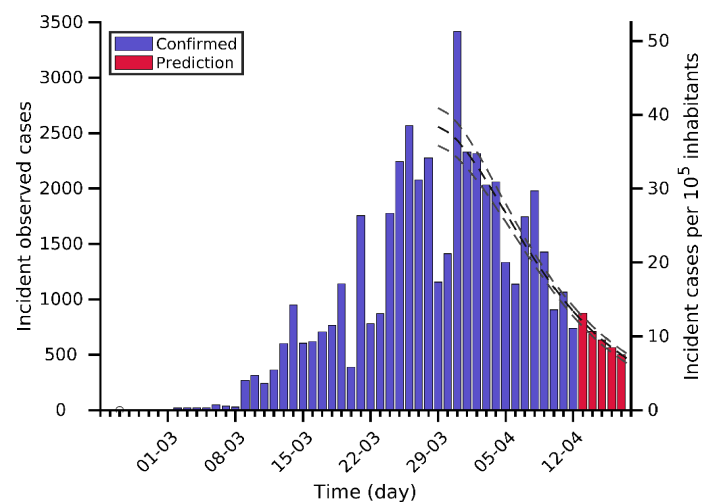
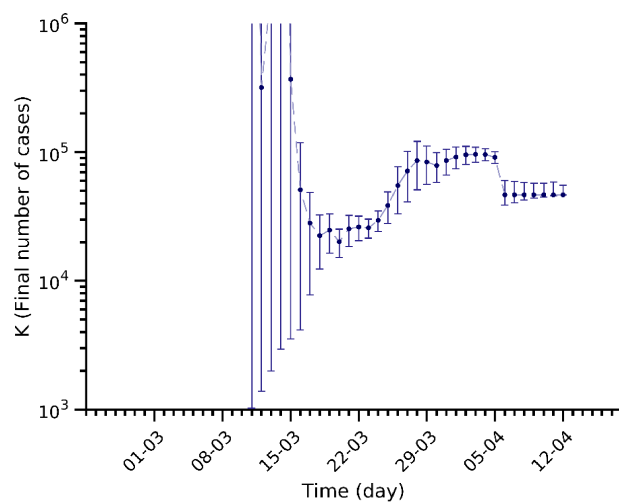
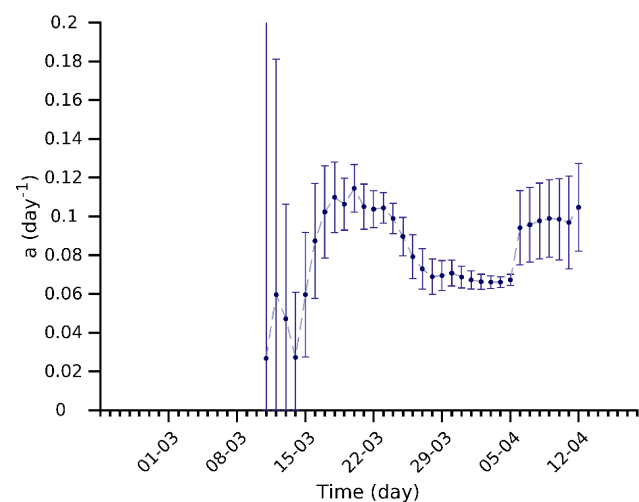
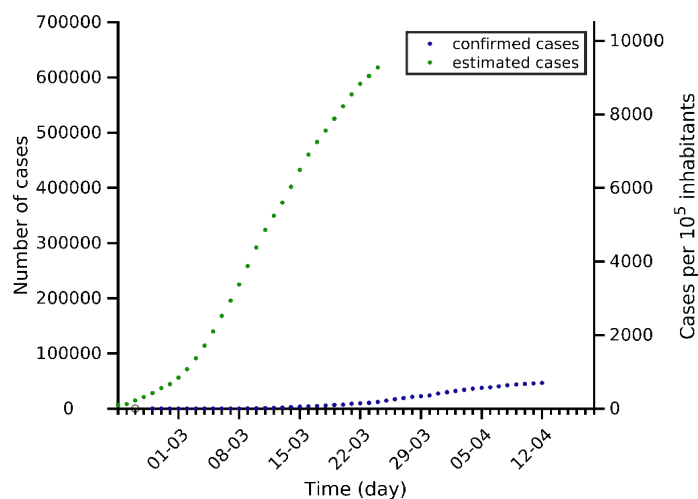
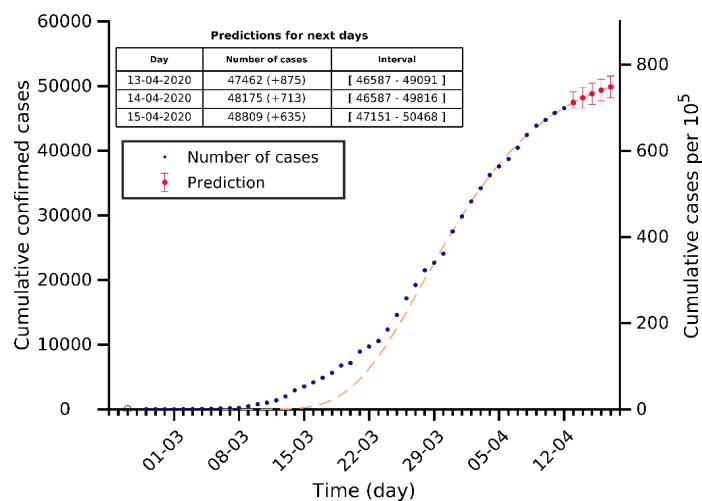
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and
<https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>

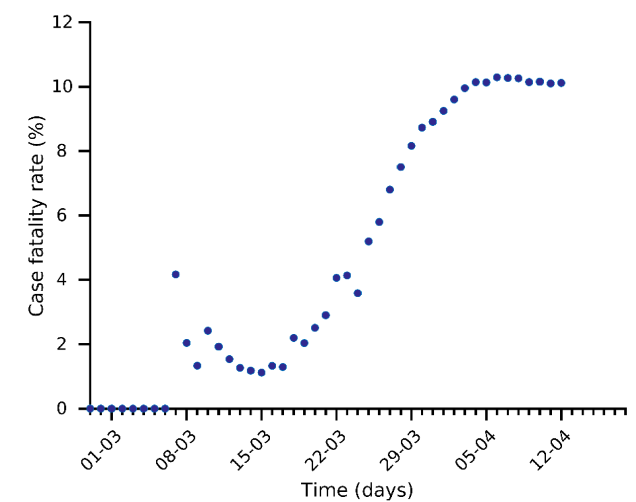
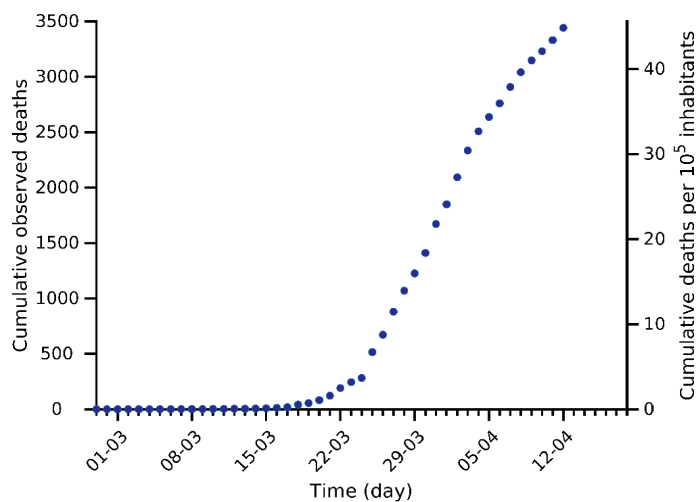
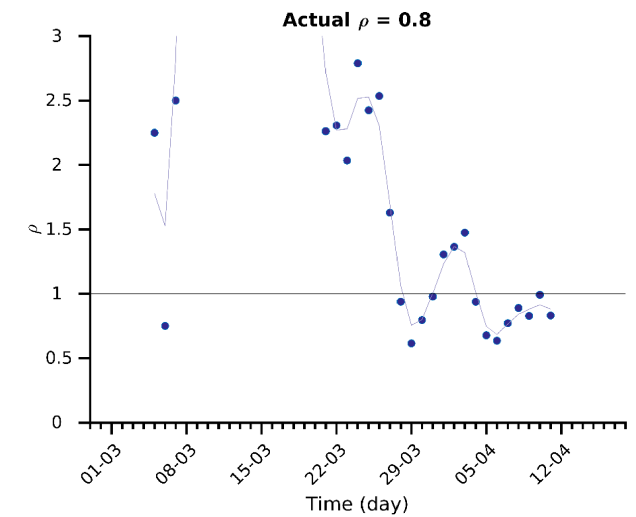
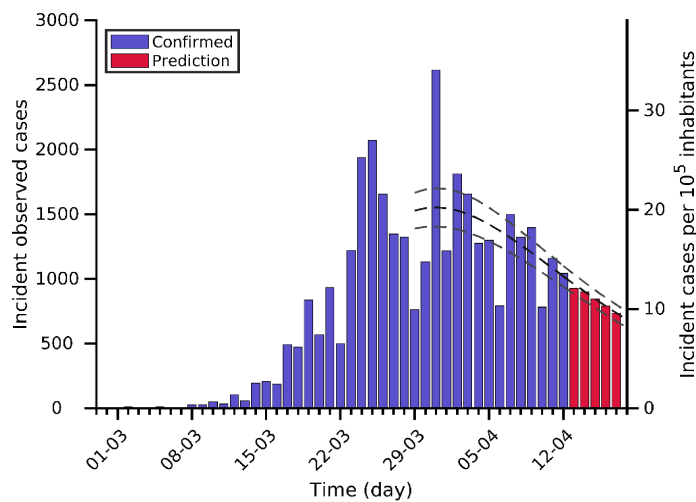
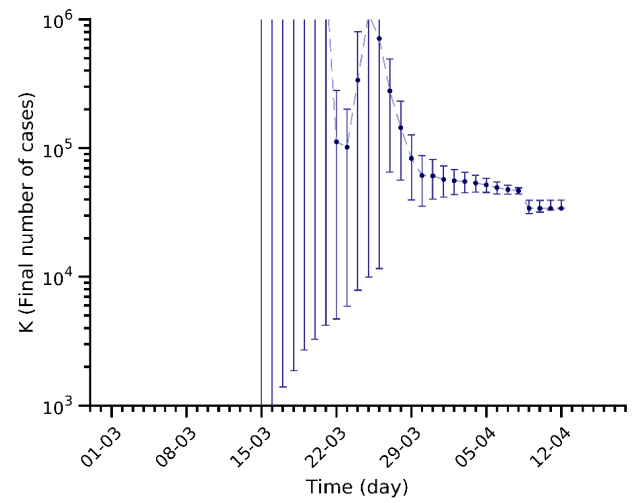
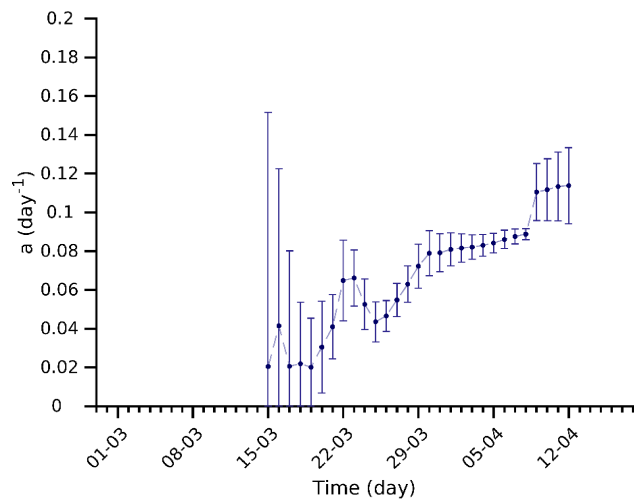
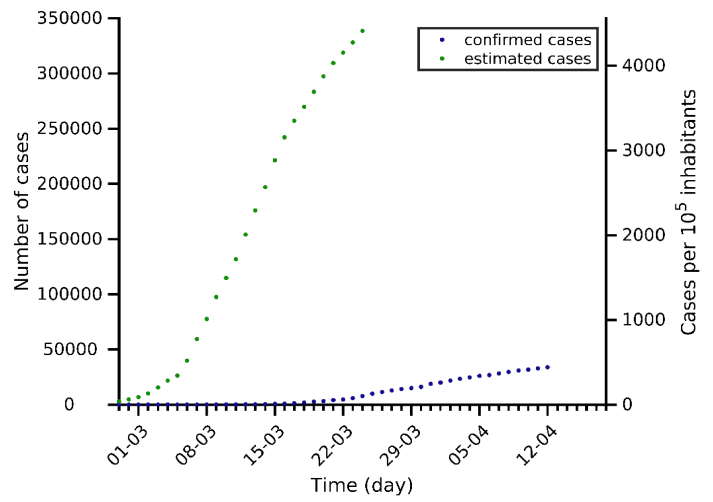
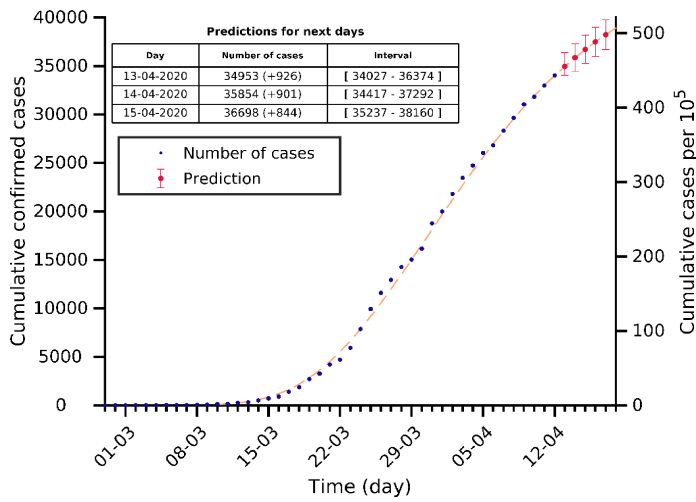
Spain 12-04-2020. Population: 47.0M. Current cumulated incidence: 353/10⁵



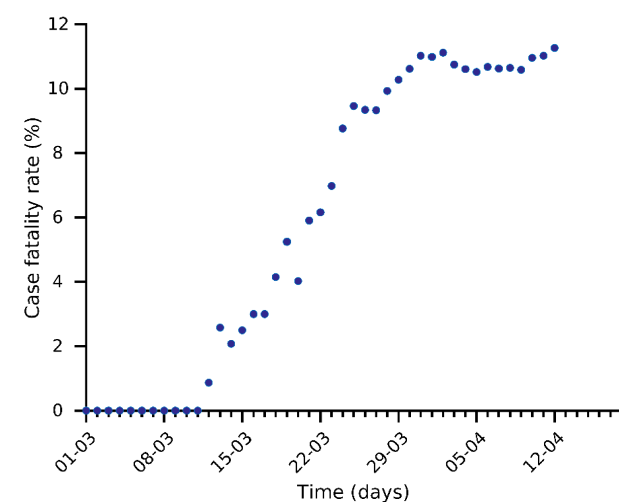
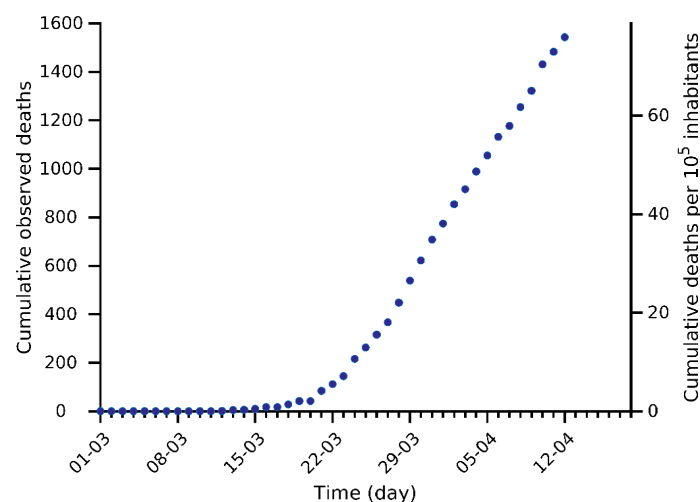
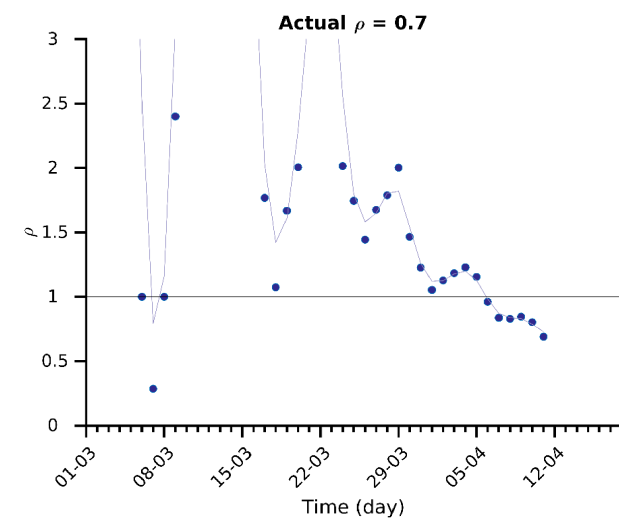
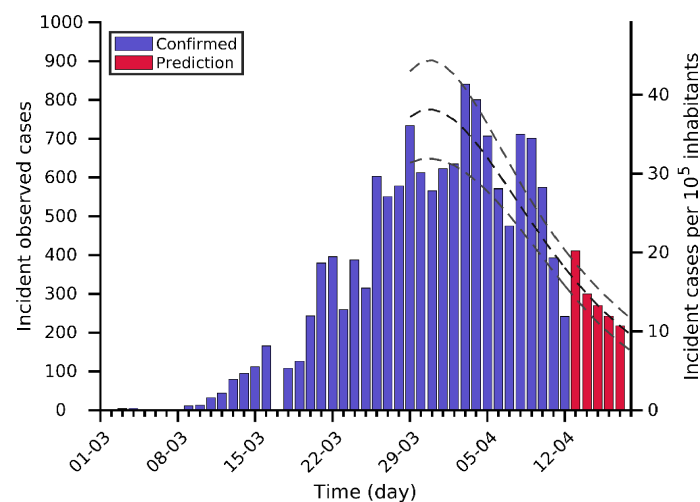
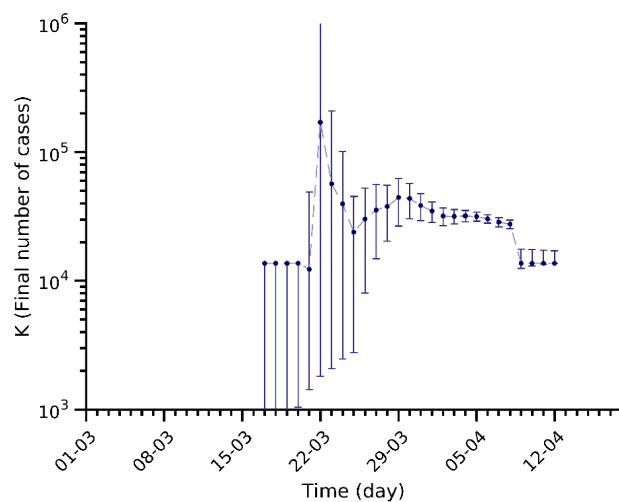
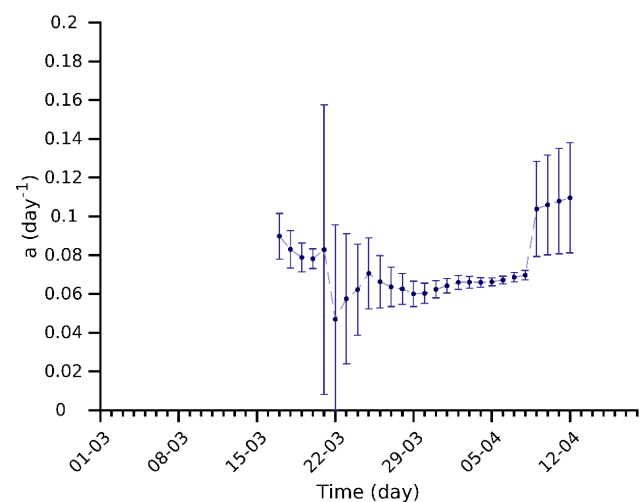
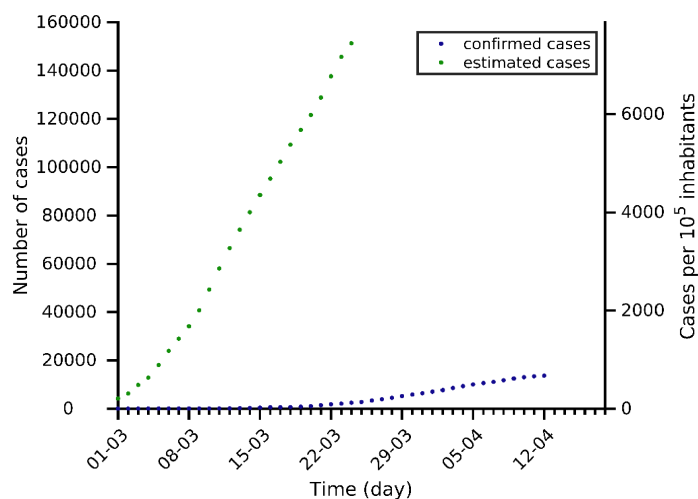
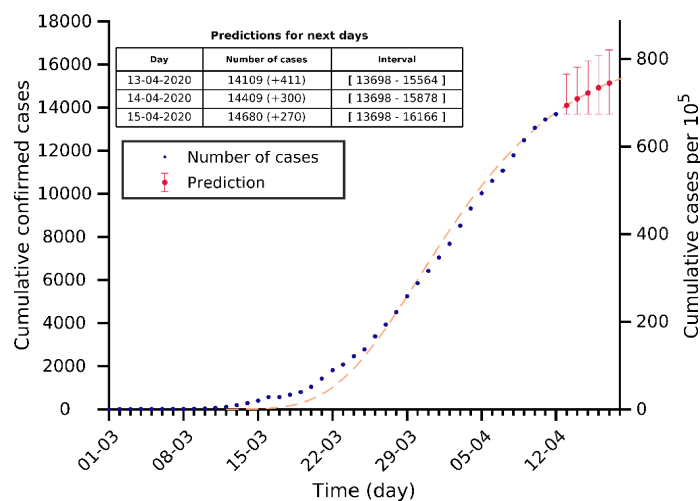
Madrid 12-04-2020. Population: 6.7M. Current cumulated incidence: 699/10⁵



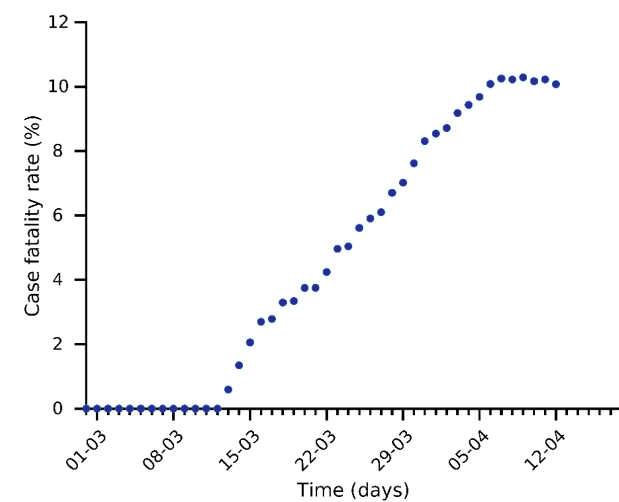
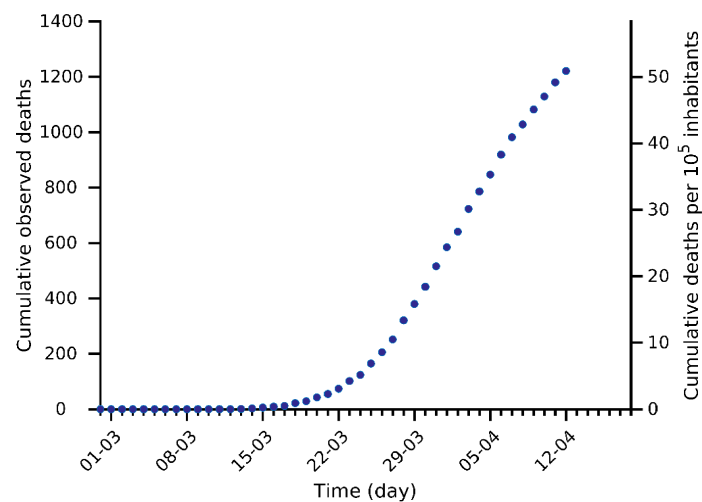
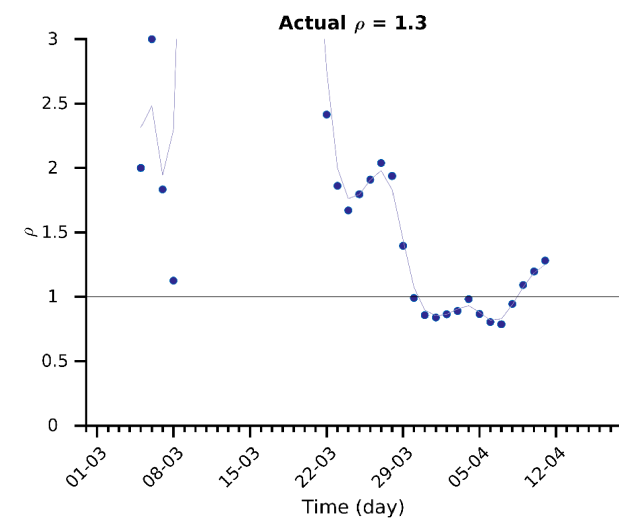
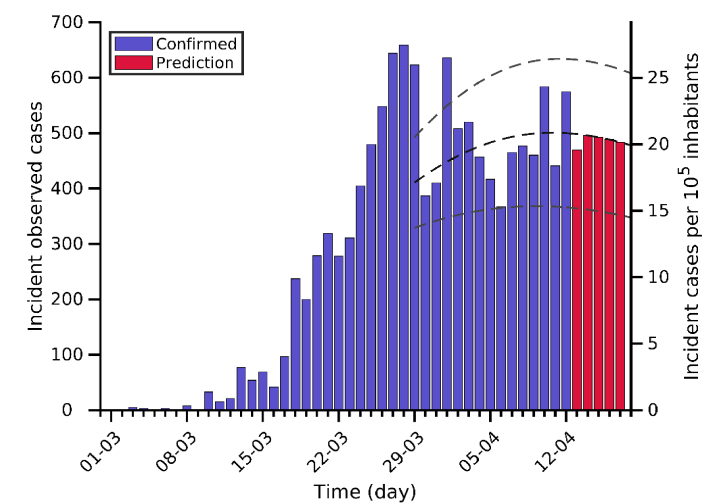
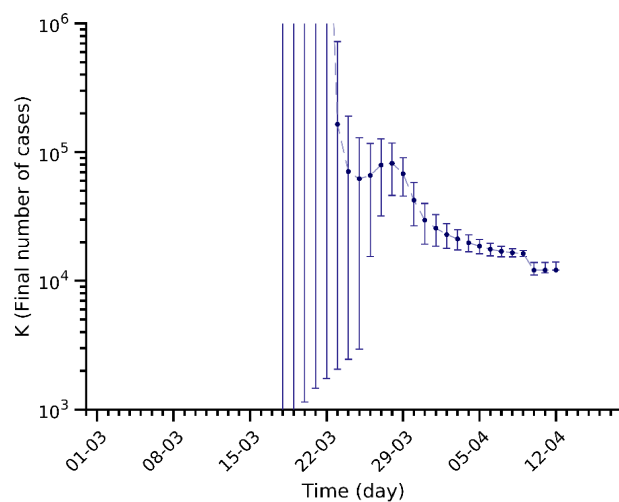
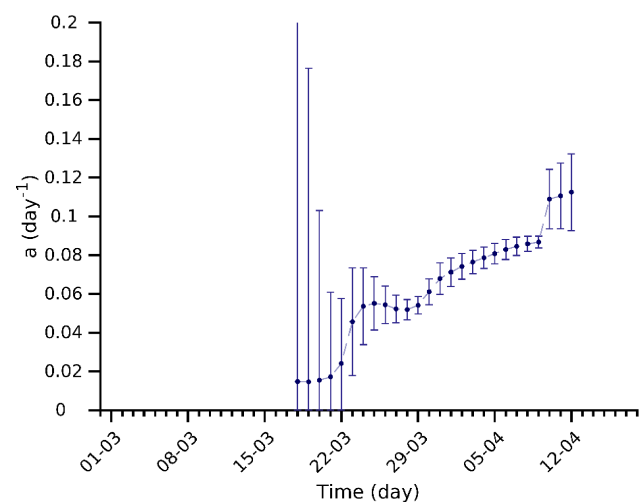
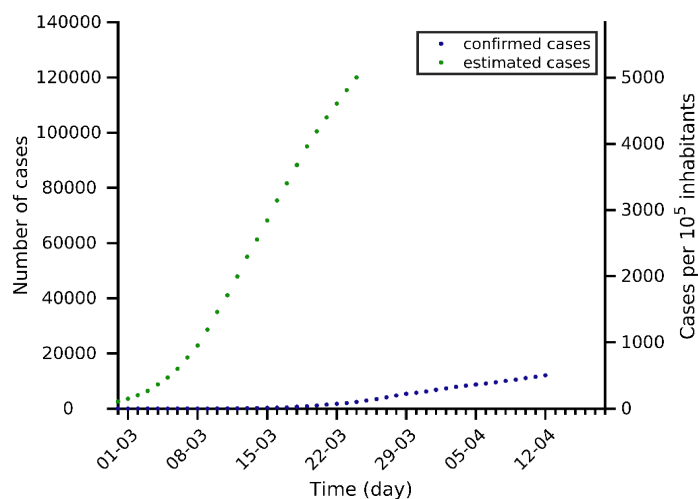
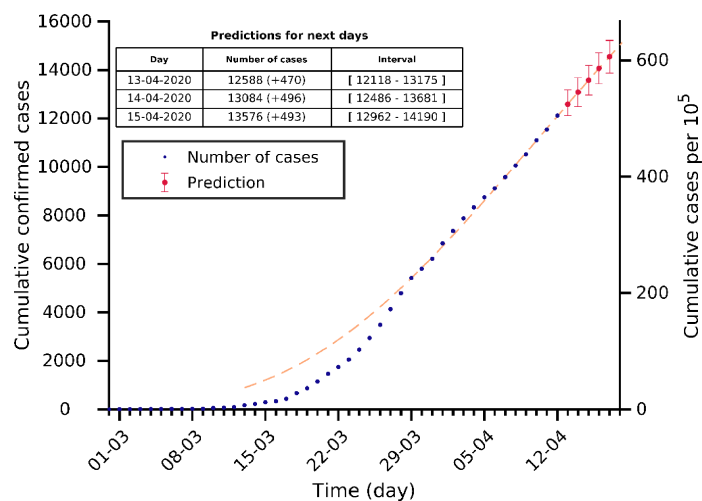
Catalunya 12-04-2020. Population: 7.7M. Current cumulated incidence: 443/10⁵



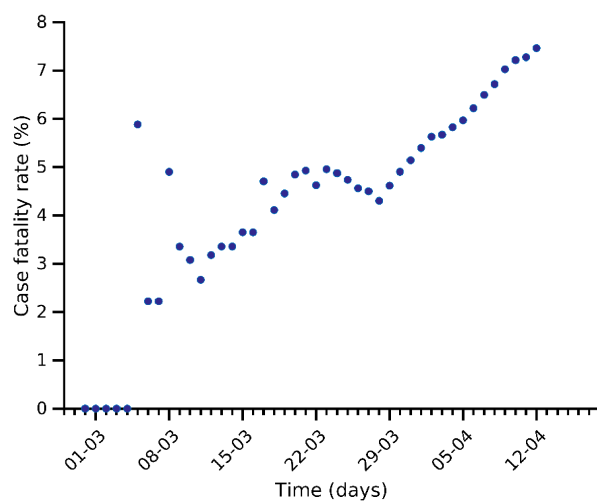
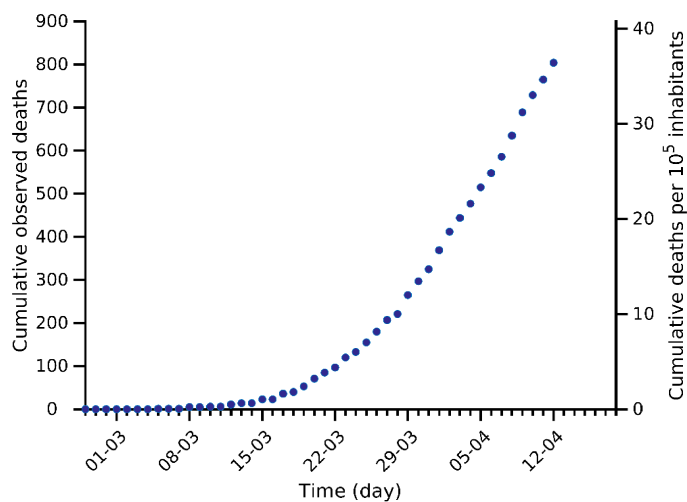
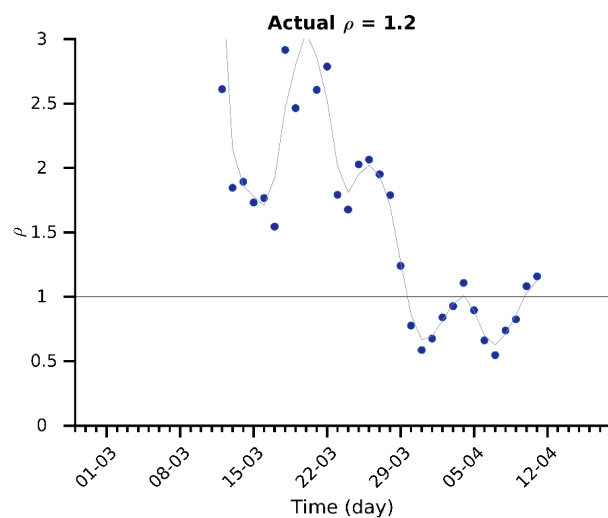
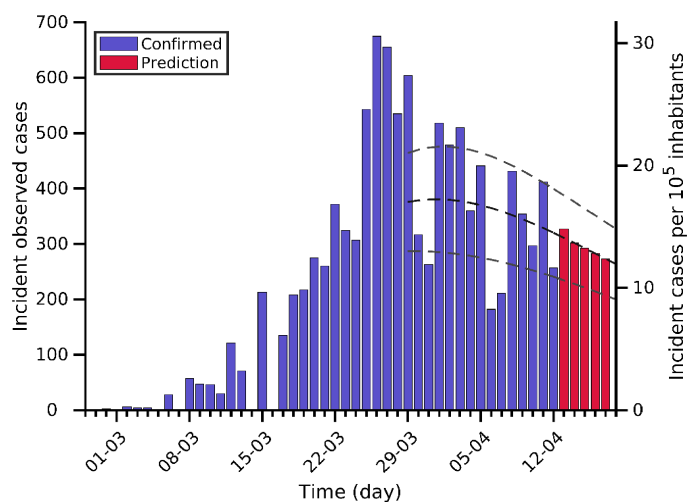
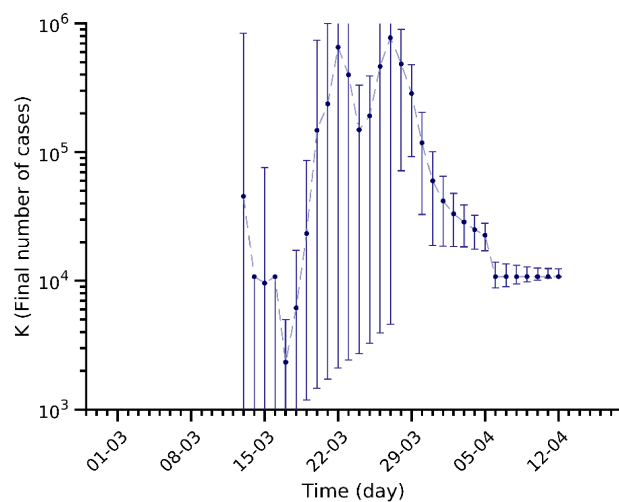
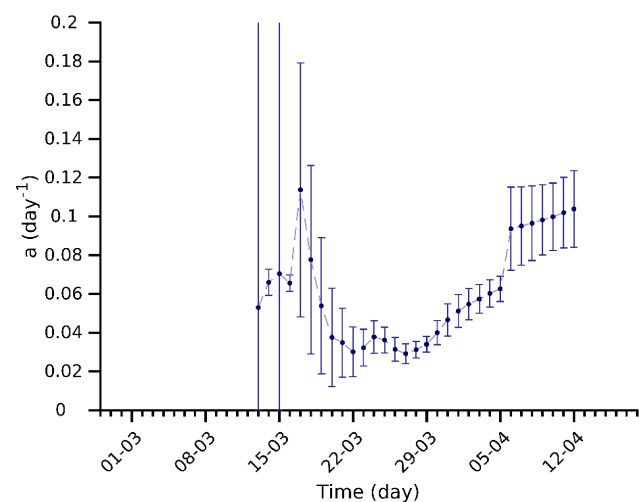
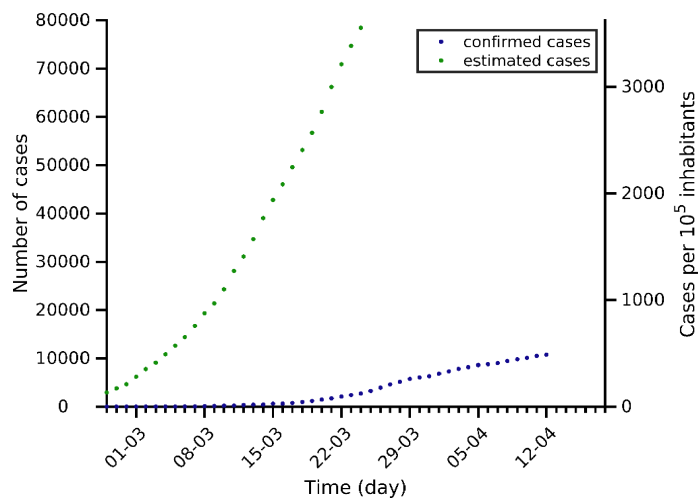
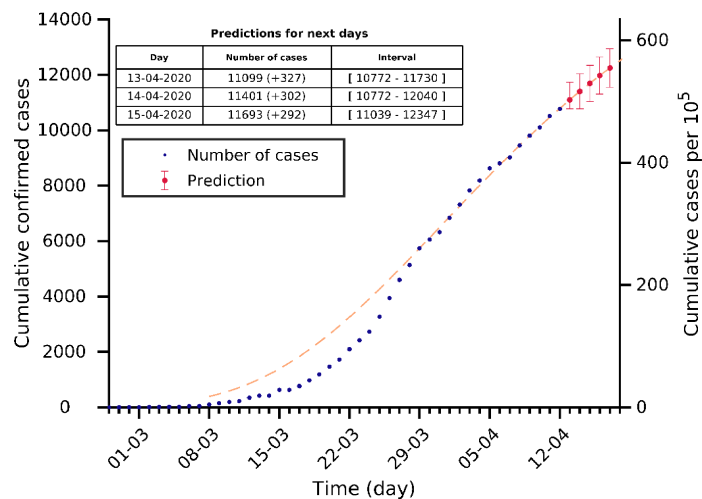
Castilla-La Mancha 12-04-2020. Population: 2.0M. Current cumulated incidence: 67



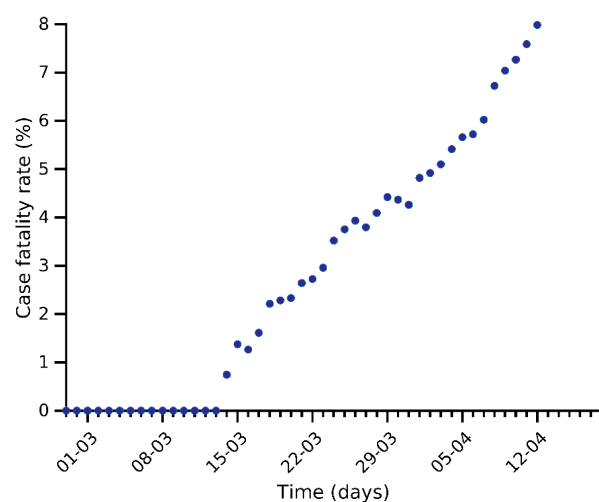
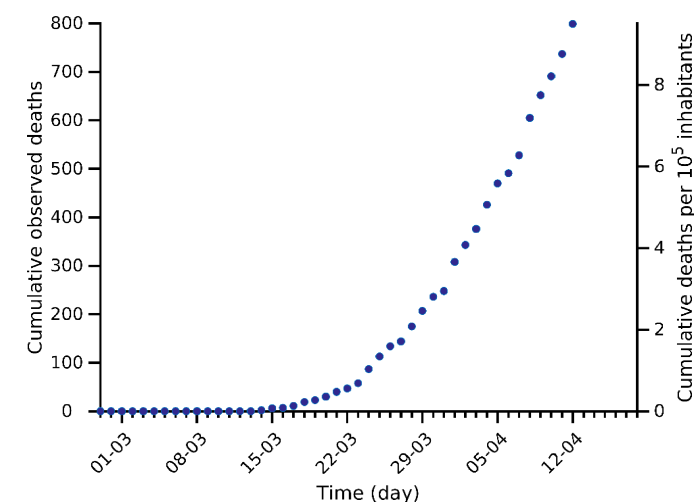
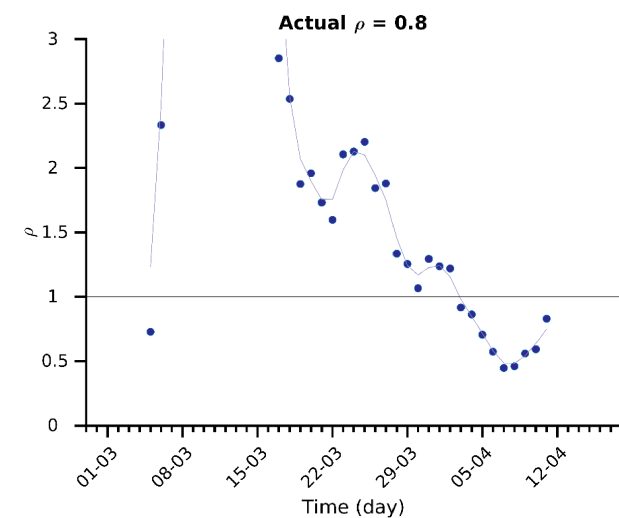
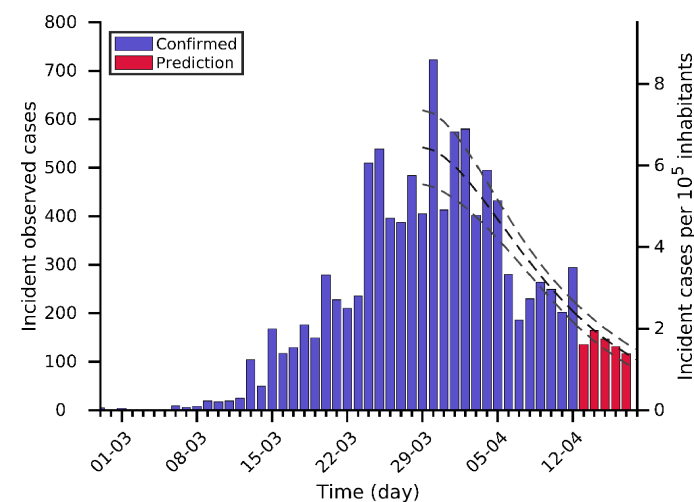
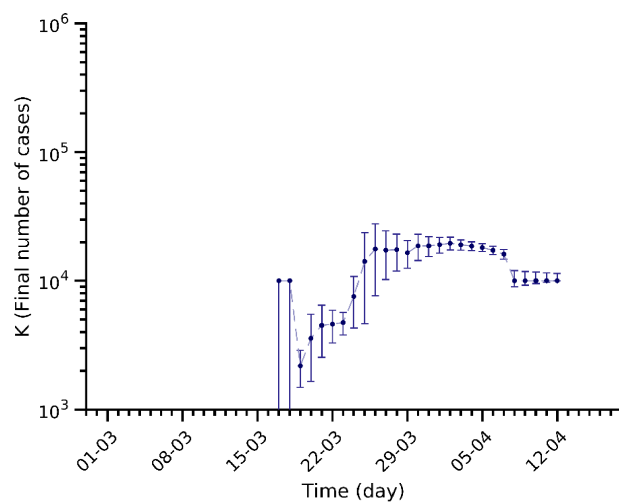
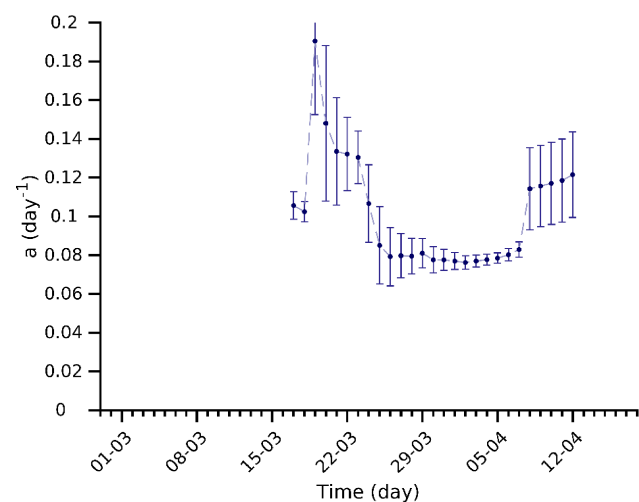
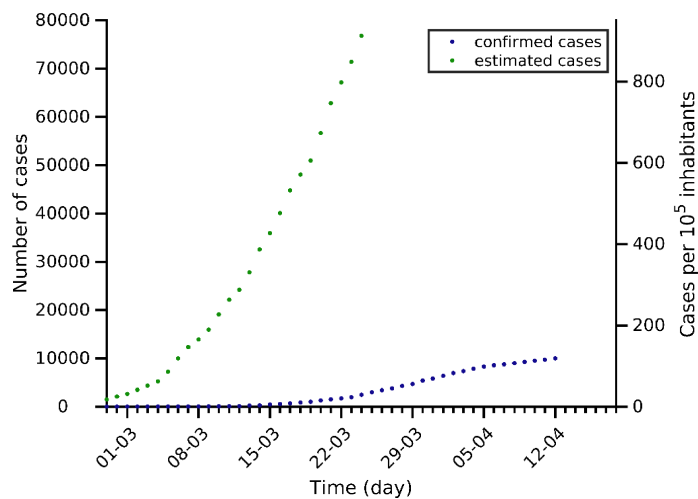
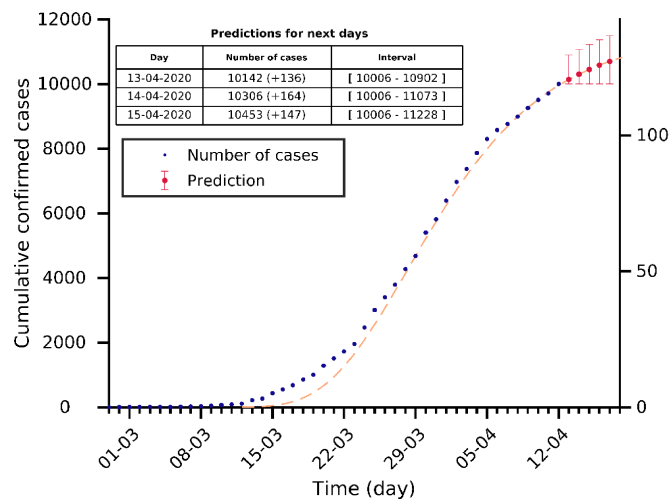
Castilla Leon 12-04-2020. Population: 2.4M. Current cumulated incidence: 505/10⁵



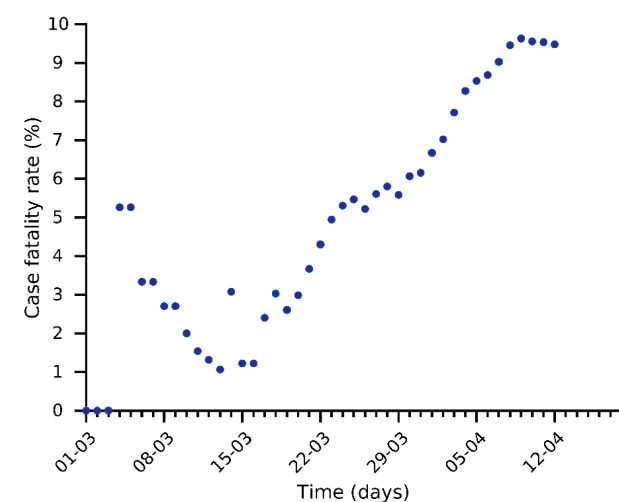
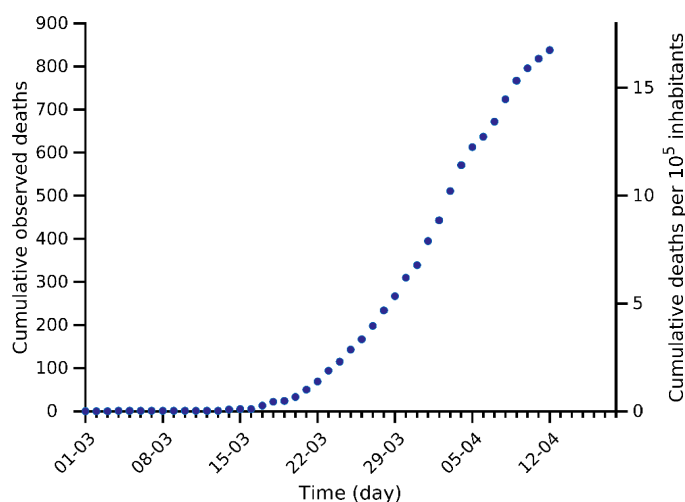
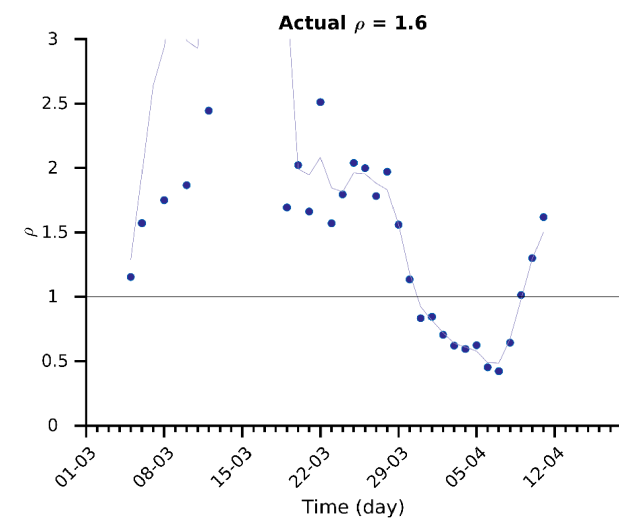
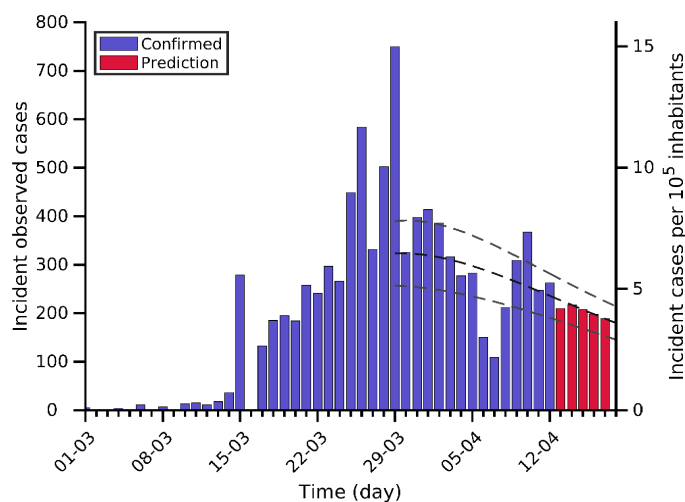
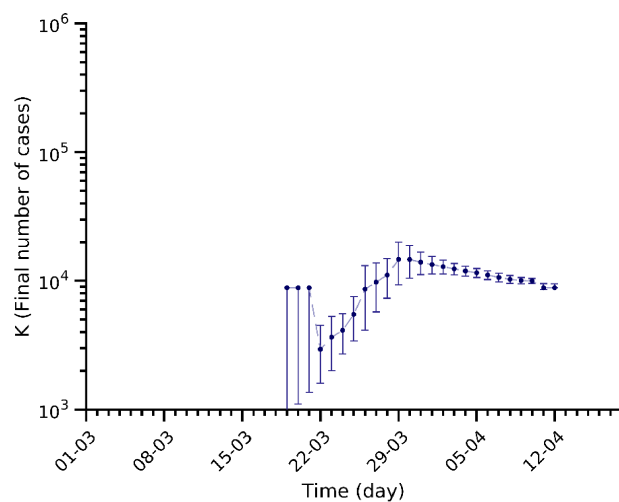
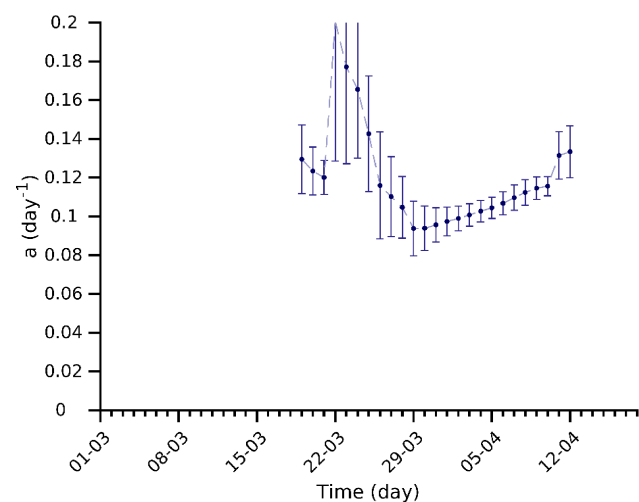
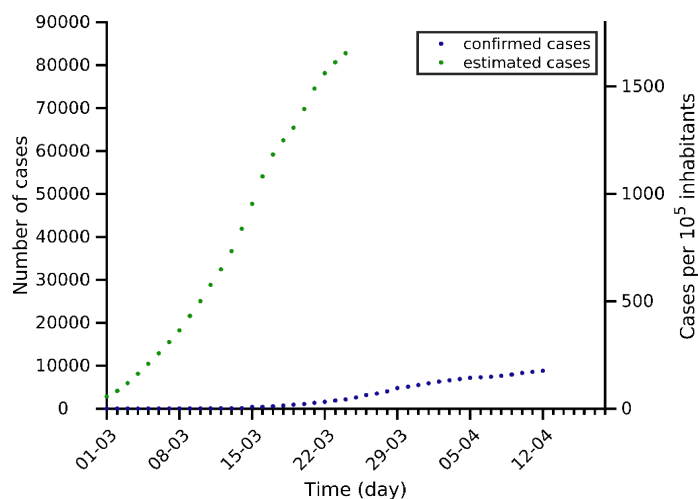
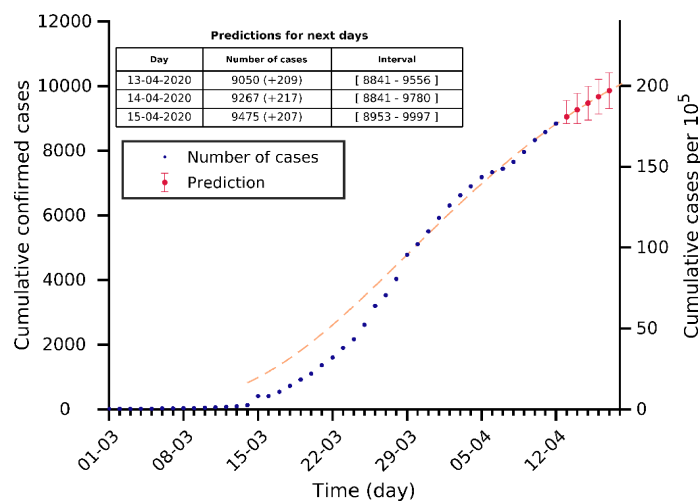
Euskadi 12-04-2020. Population: 2.2M. Current cumulated incidence: 488/10⁵



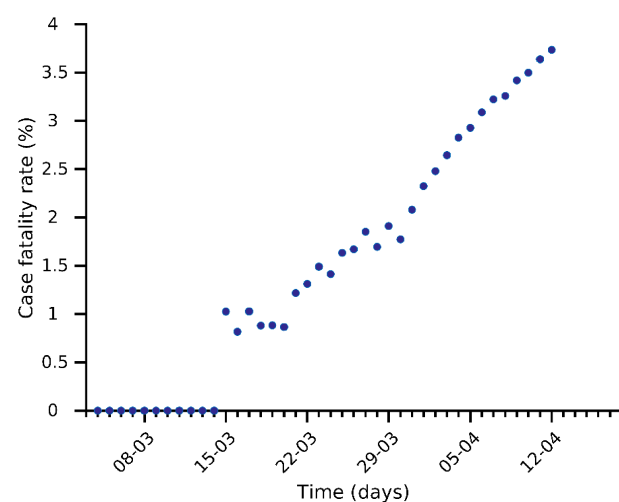
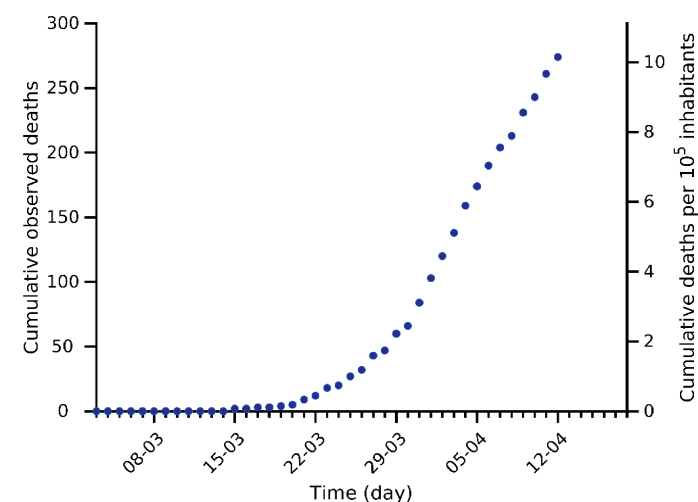
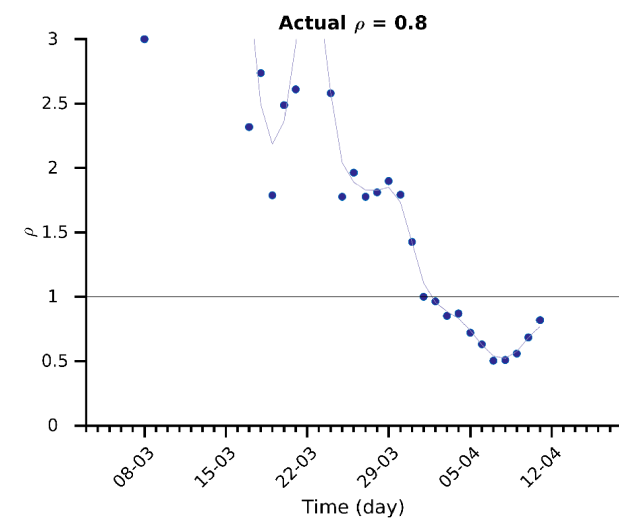
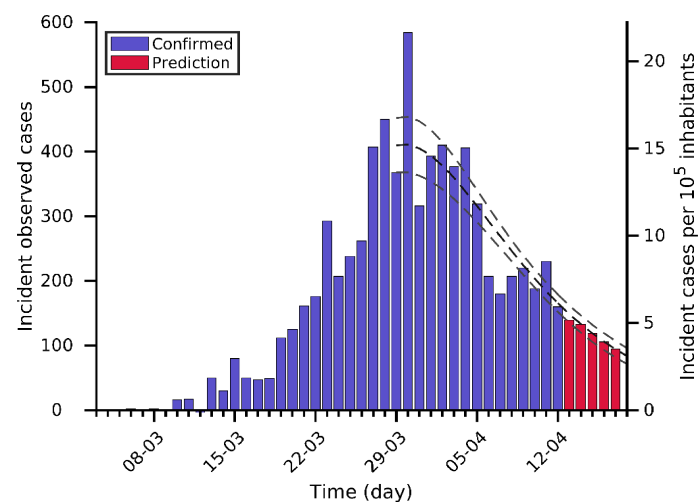
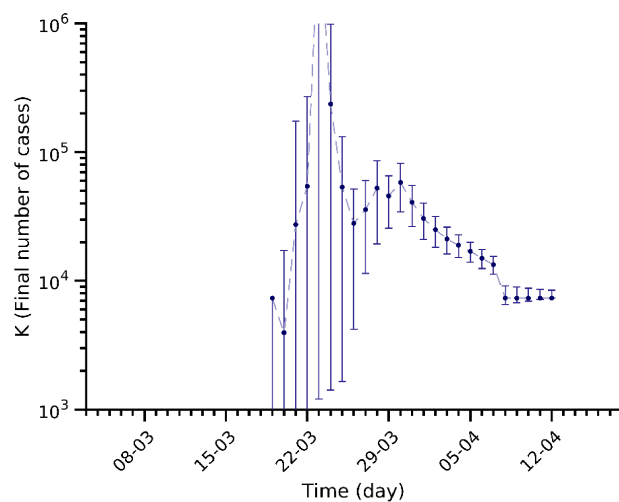
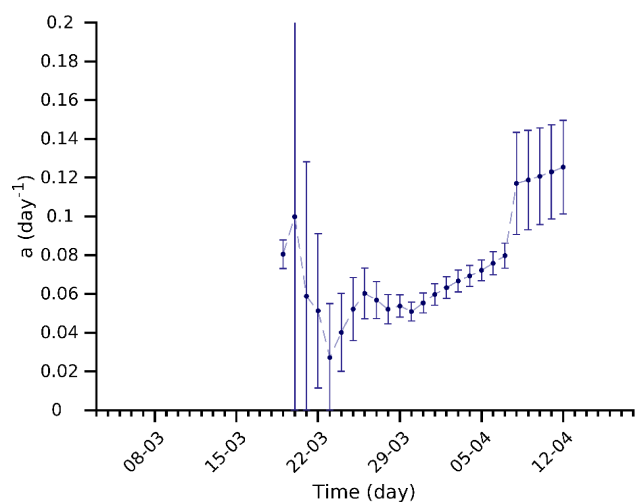
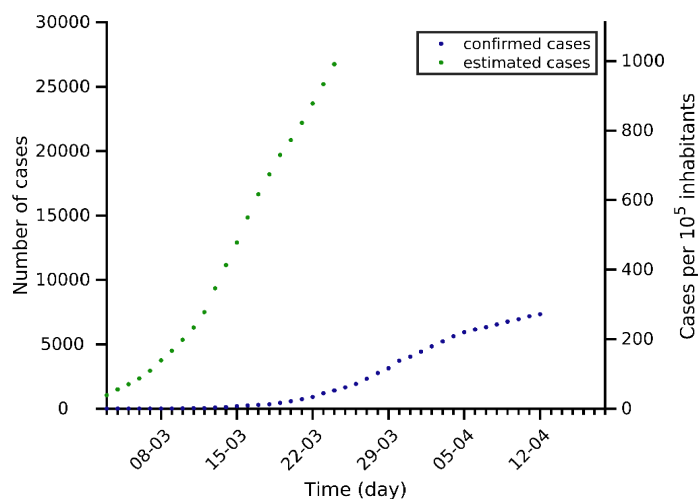
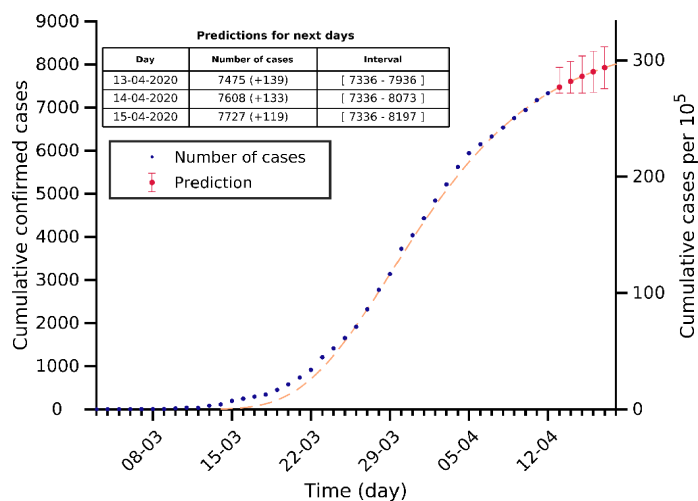
Andalucia 12-04-2020. Population: 8.4M. Current cumulated incidence: 119/10⁵



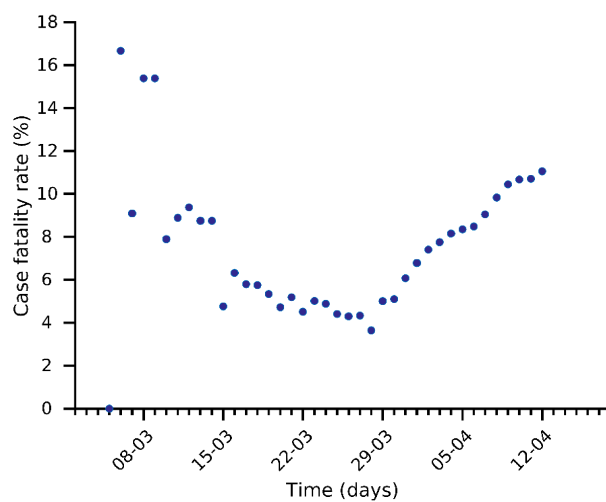
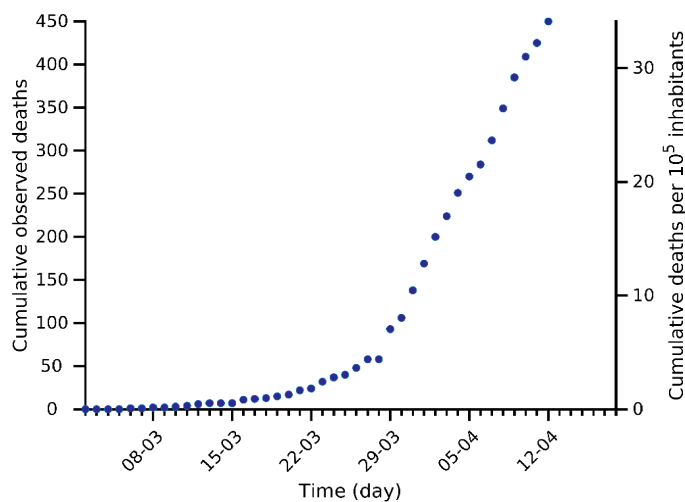
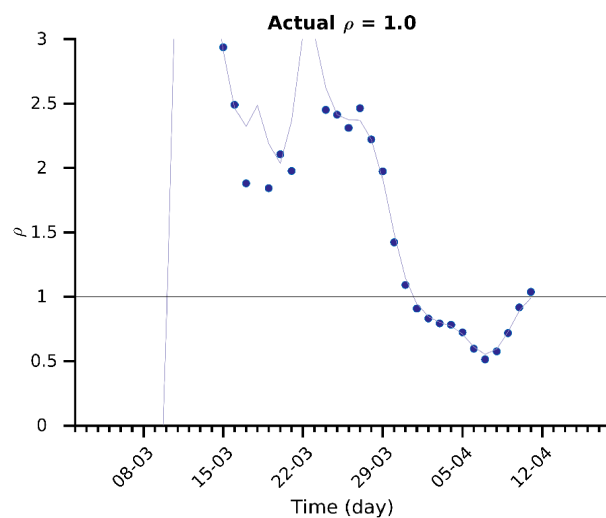
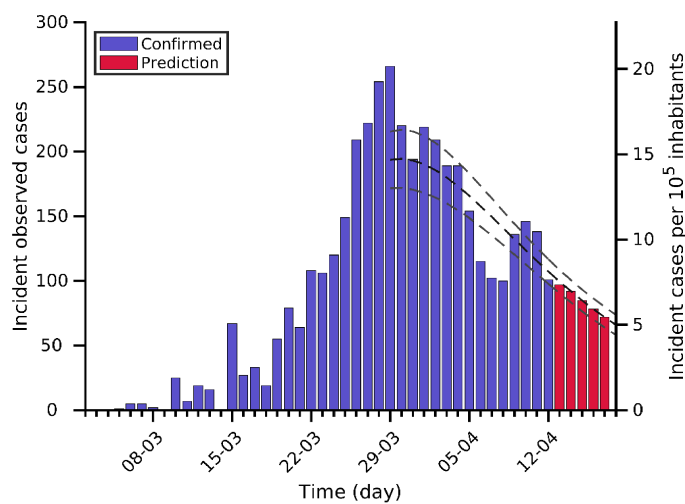
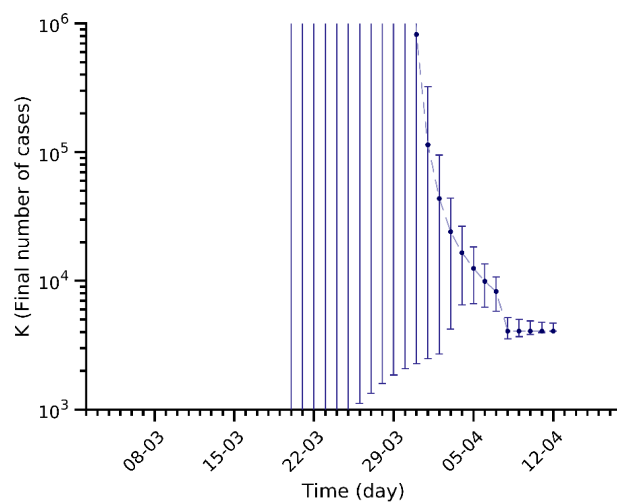
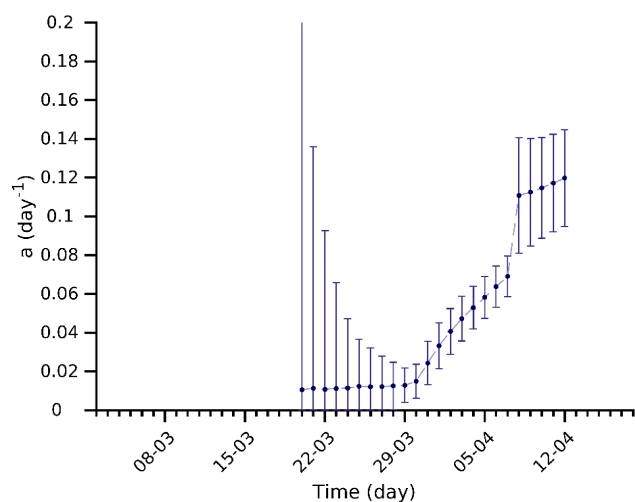
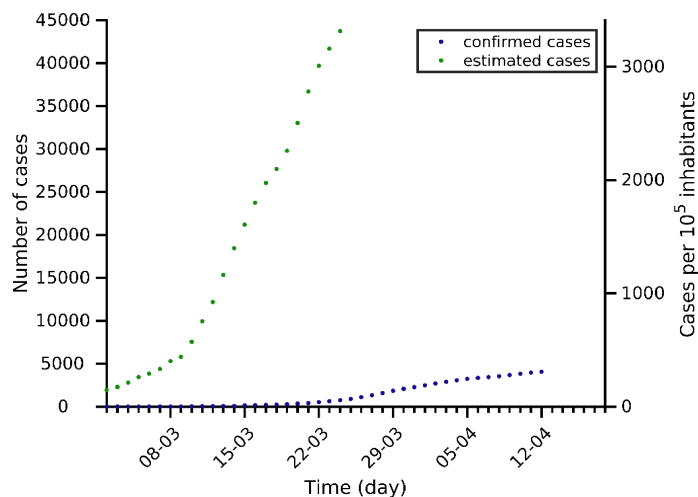
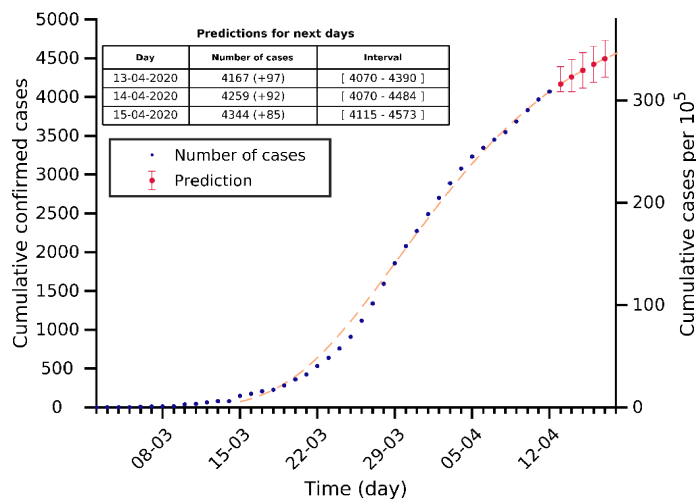
C Valenciana 12-04-2020. Population: 5.0M. Current cumulated incidence: 177/10⁵



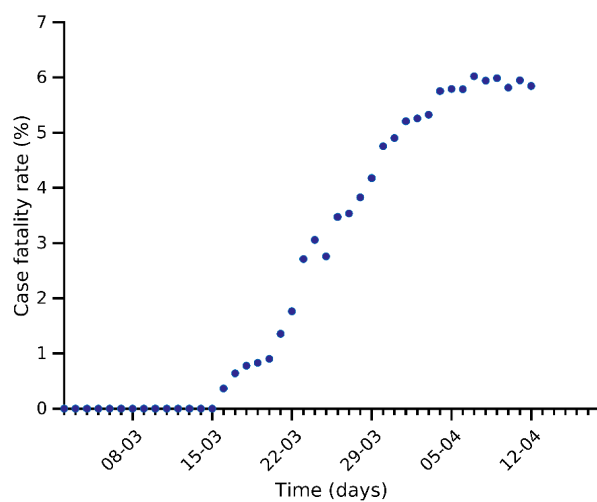
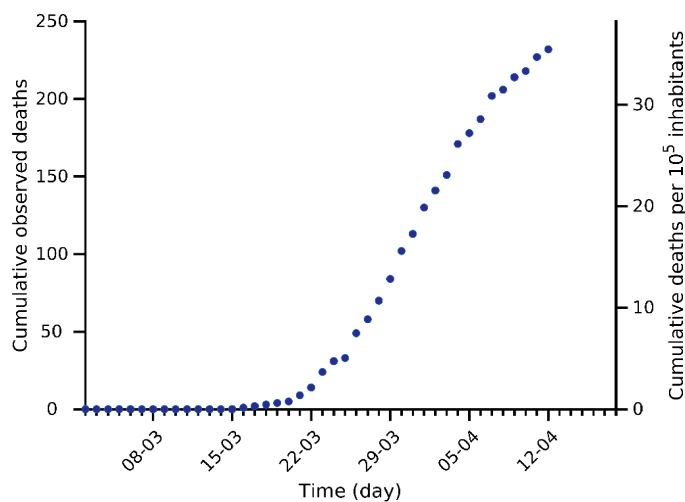
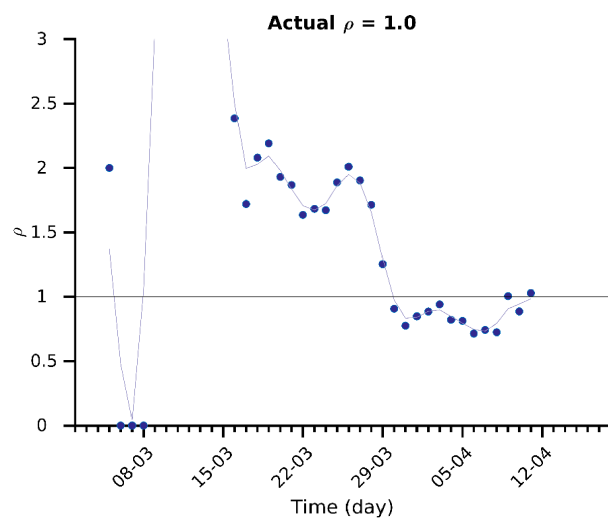
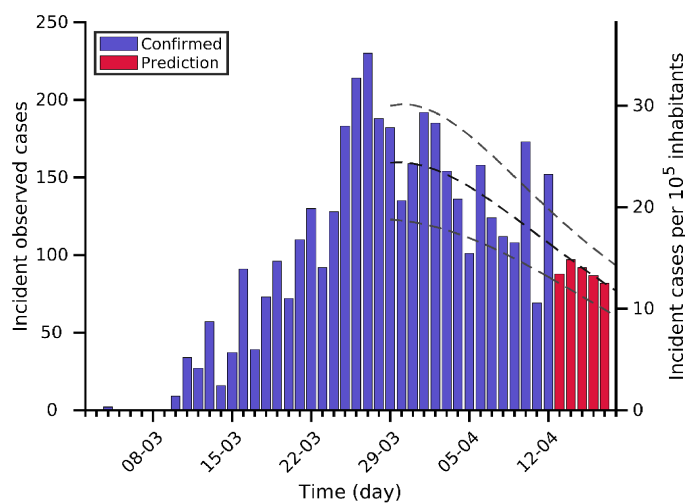
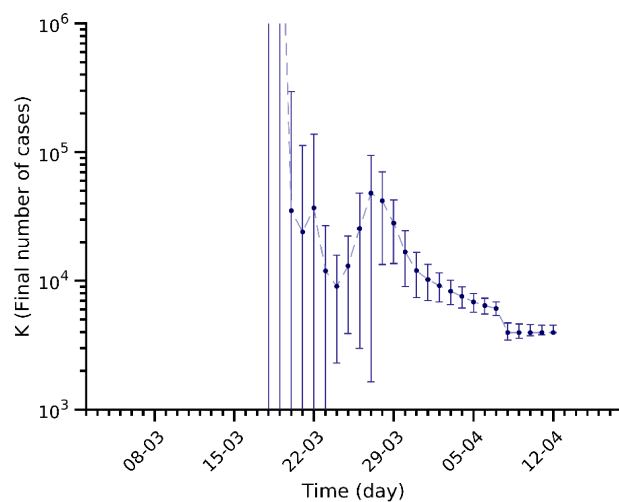
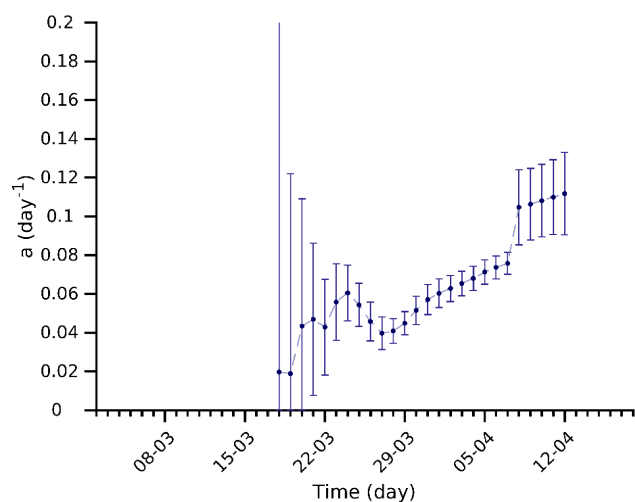
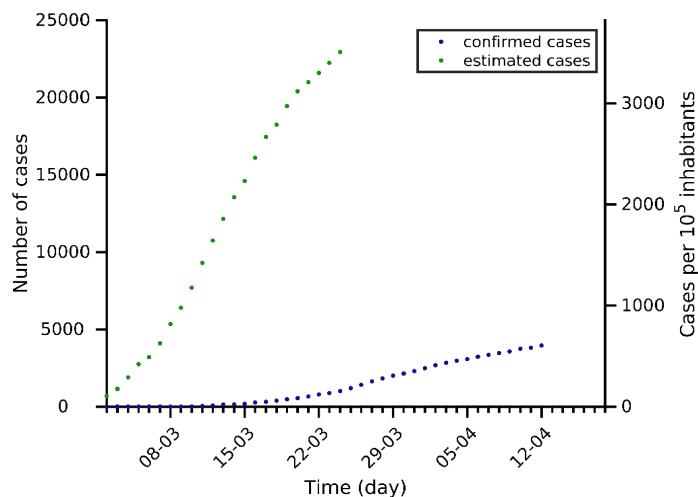
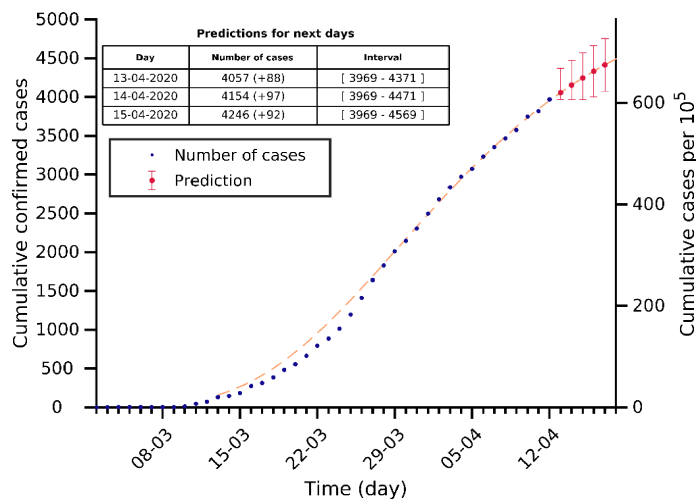
Galicia 12-04-2020. Population: 2.7M. Current cumulated incidence: 272/10⁵



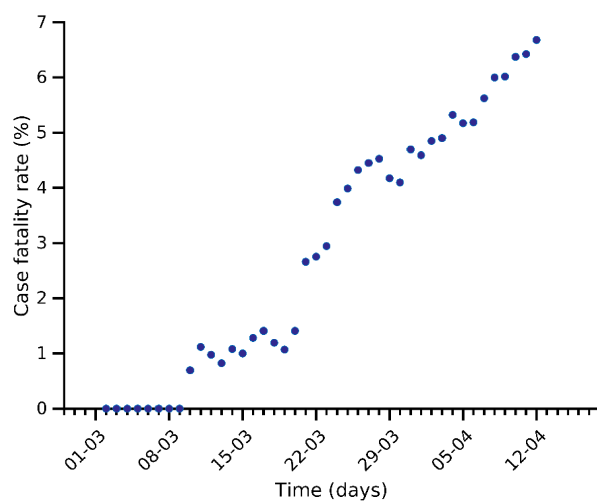
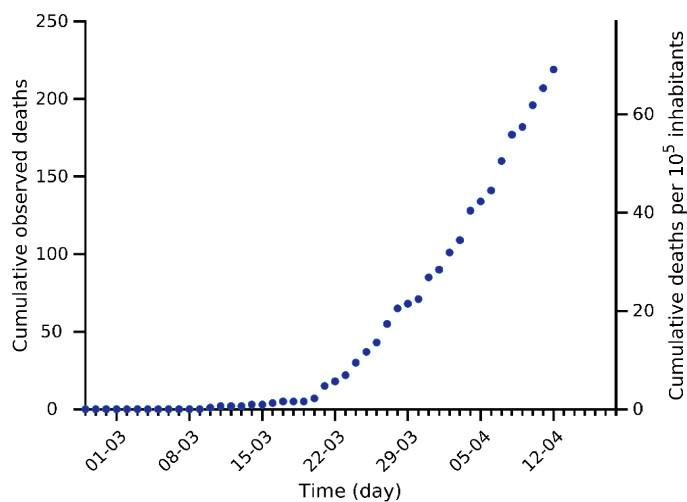
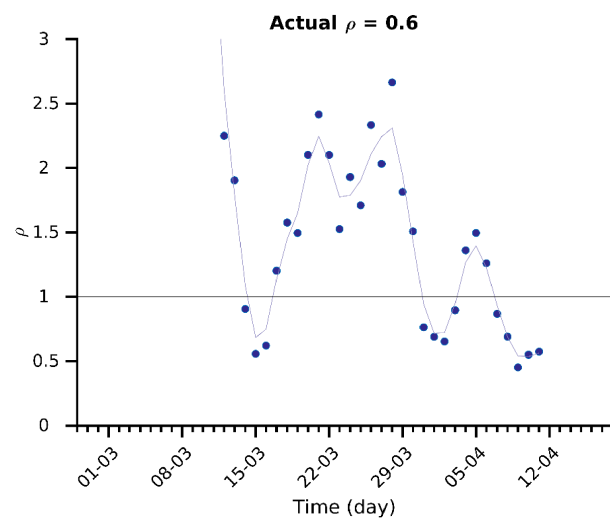
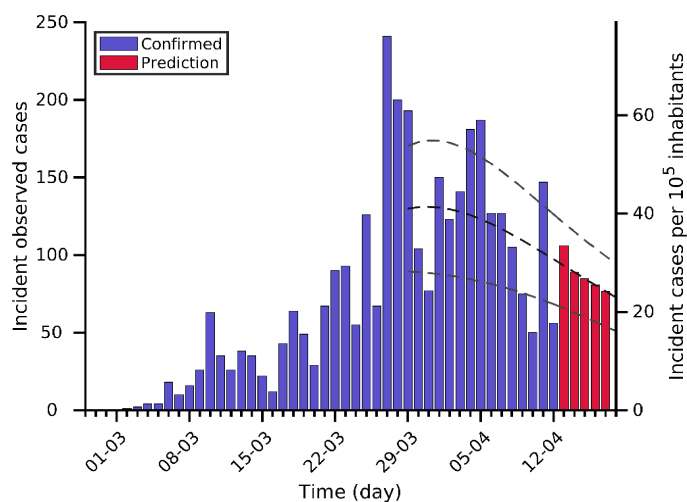
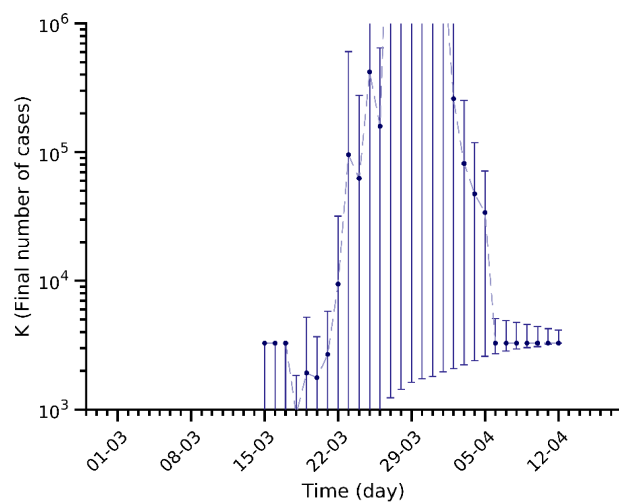
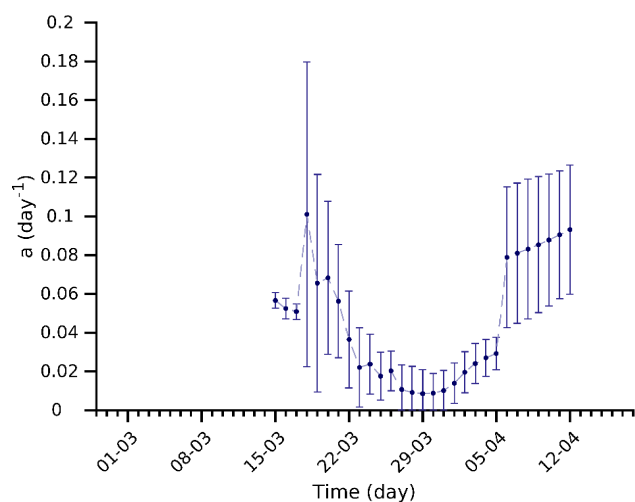
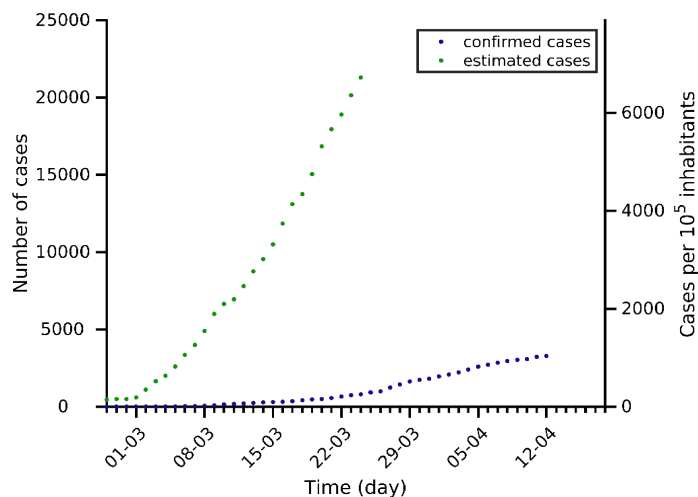
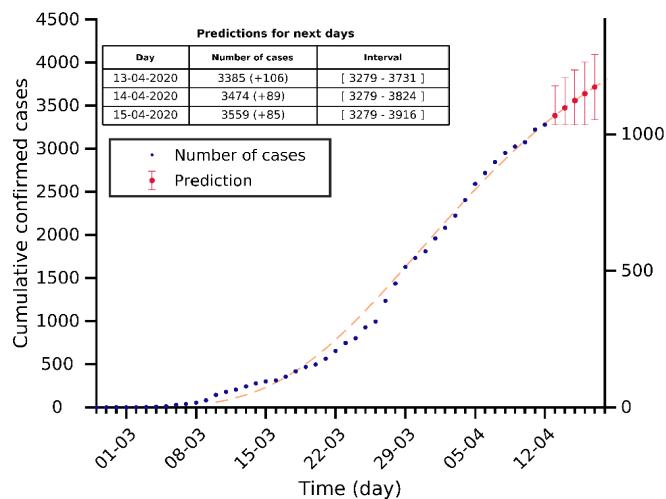
Aragon 12-04-2020. Population: 1.3M. Current cumulated incidence: 308/10⁵



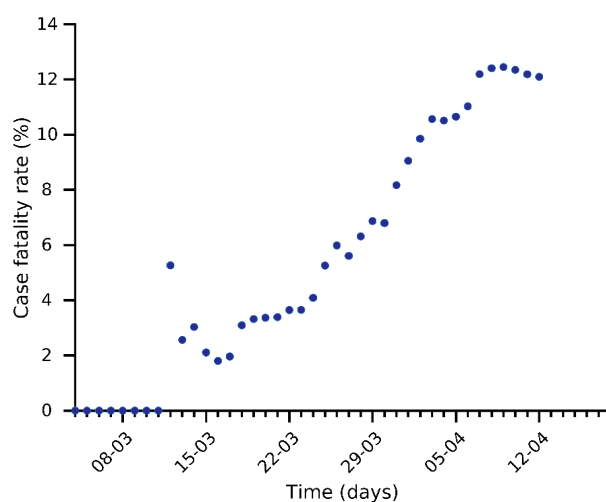
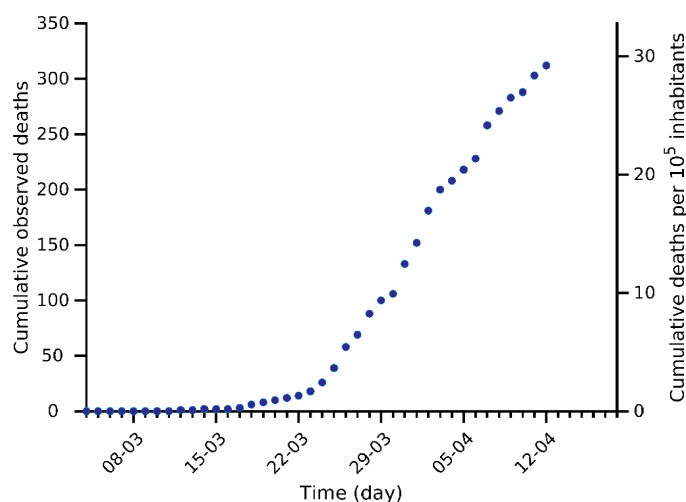
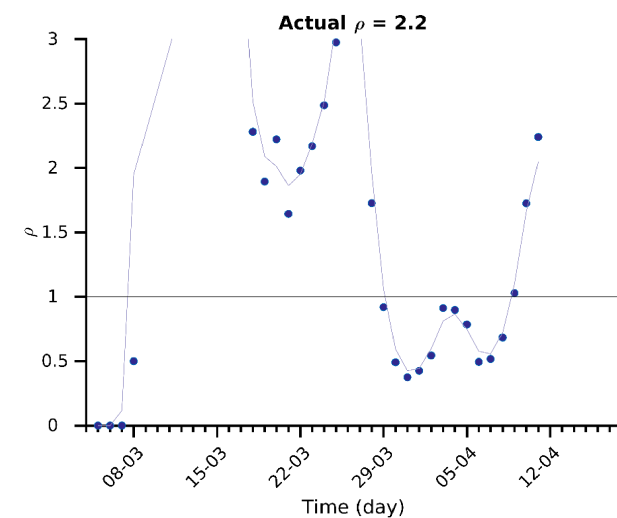
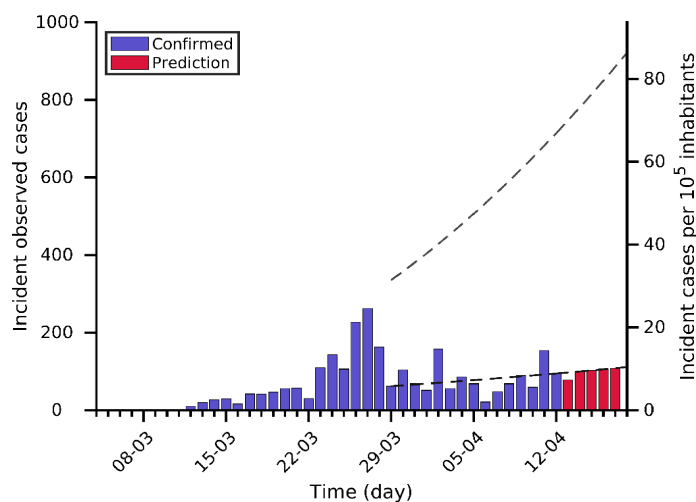
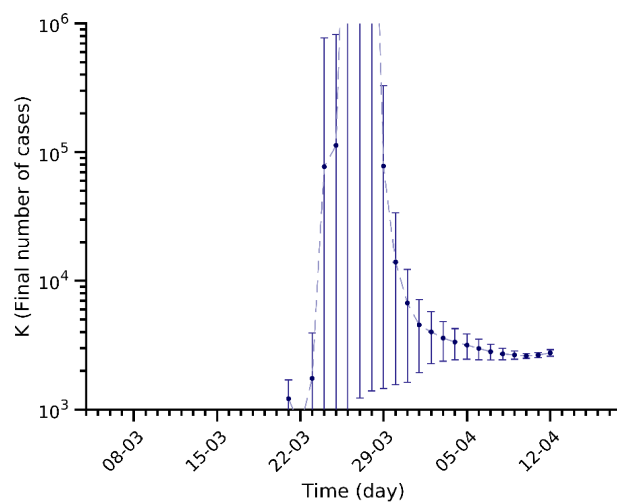
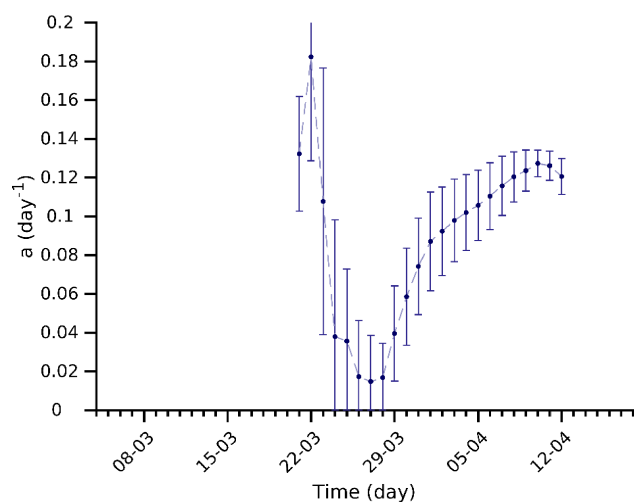
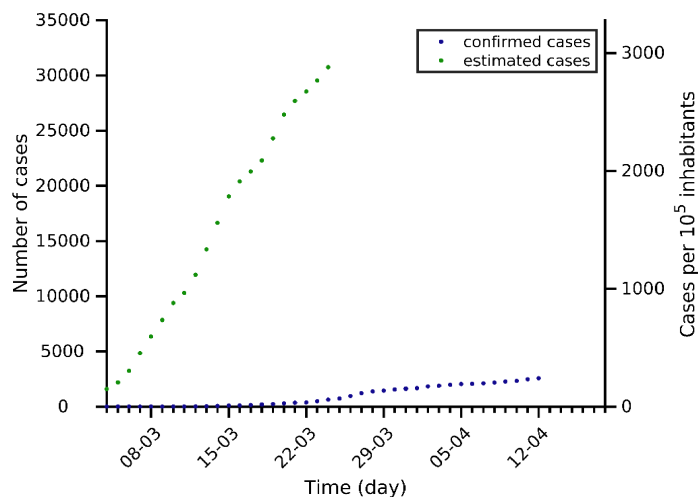
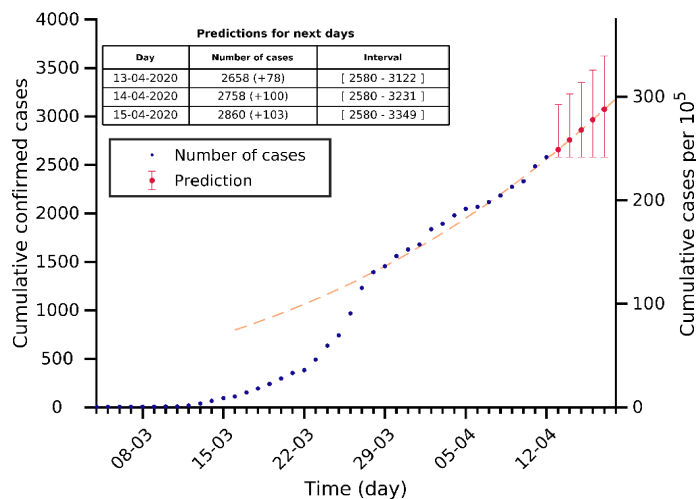
Navarra 12-04-2020. Population: 0.7M. Current cumulated incidence: 607/10⁵



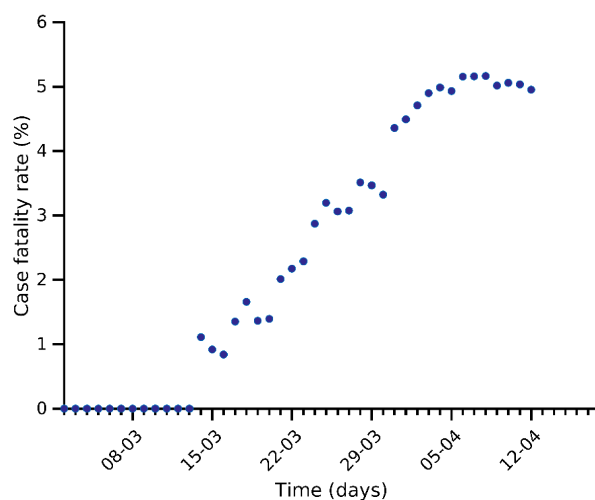
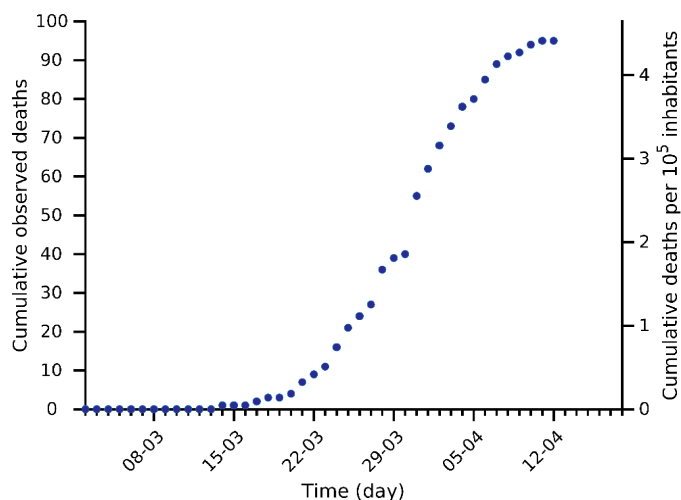
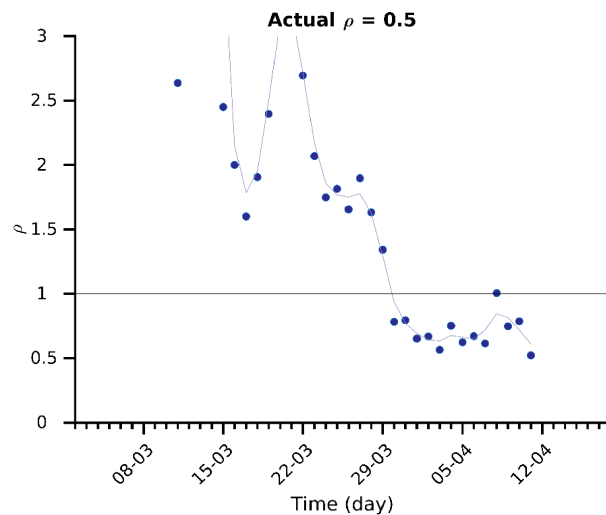
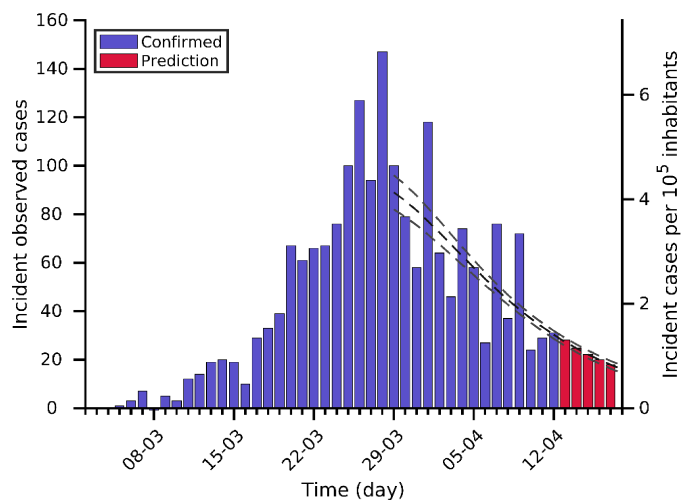
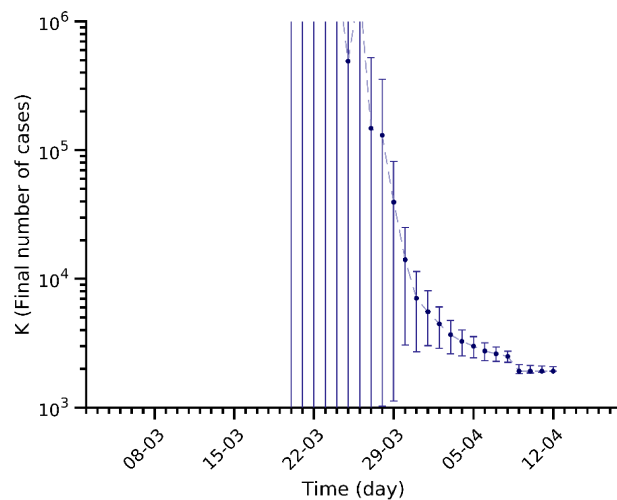
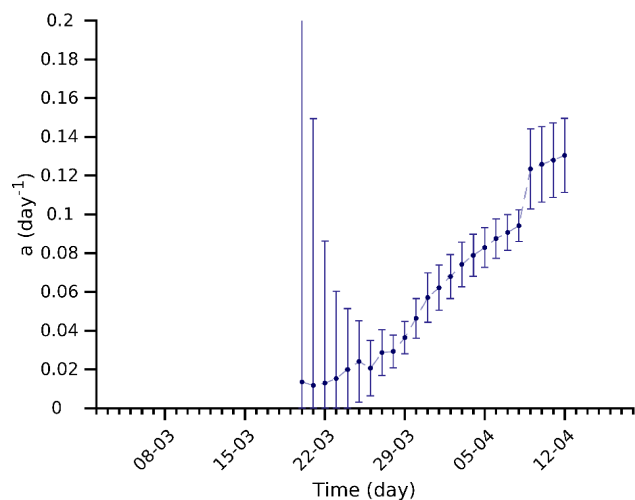
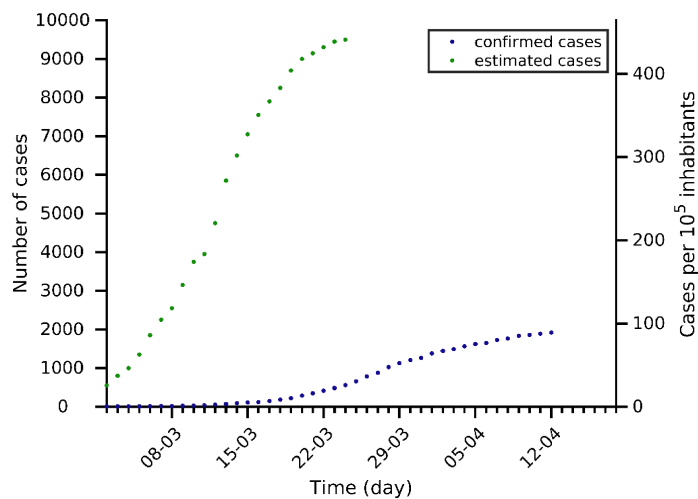
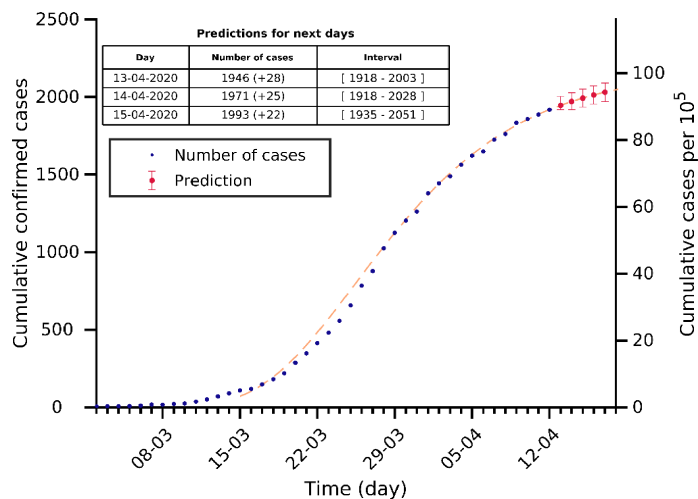
La Rioja 12-04-2020. Population: 0.3M. Current cumulated incidence: 1035/10⁵



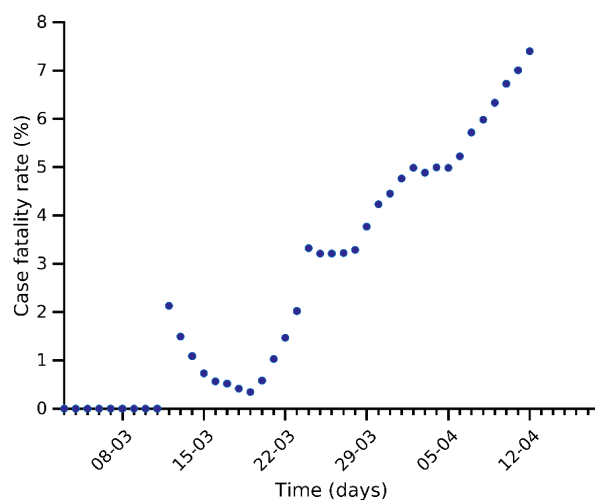
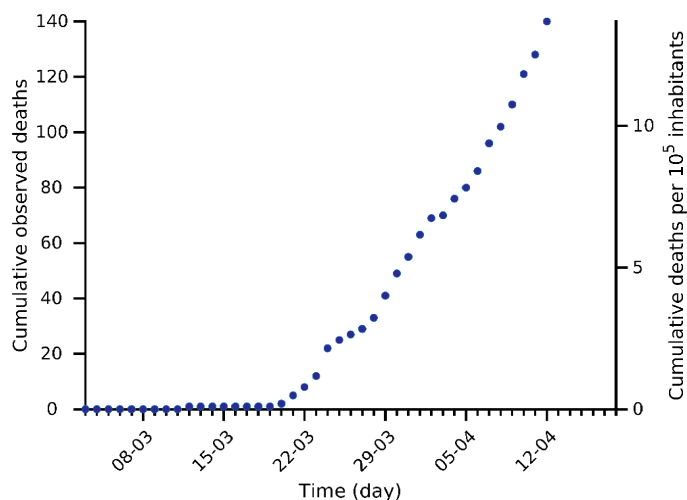
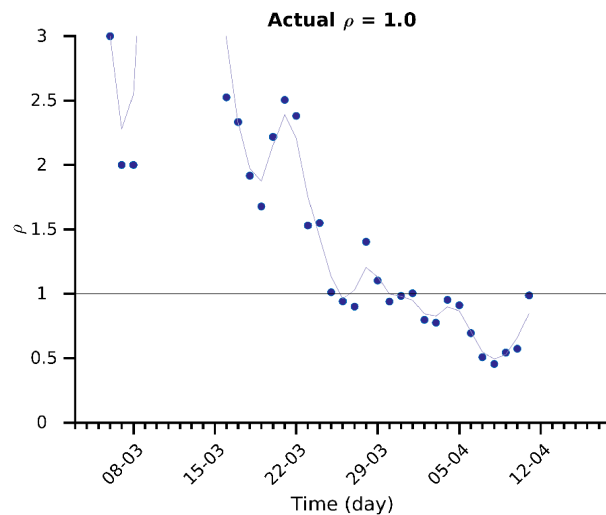
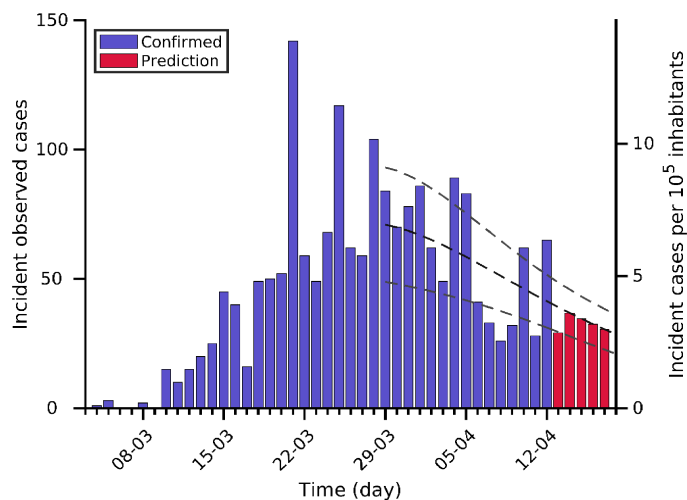
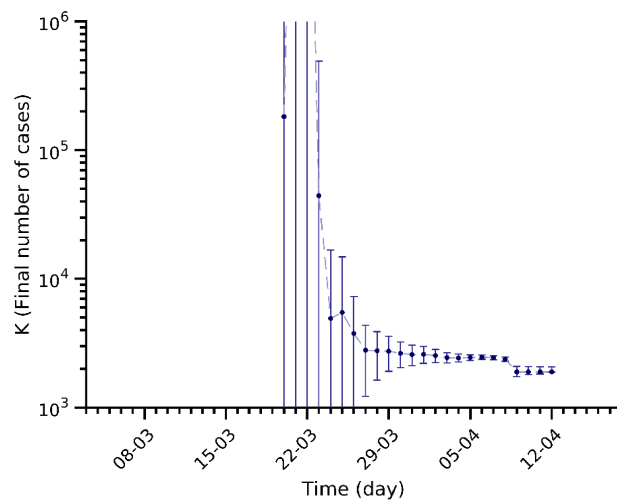
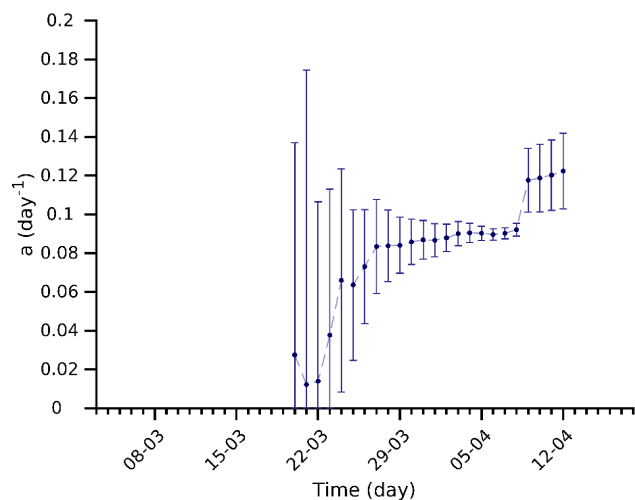
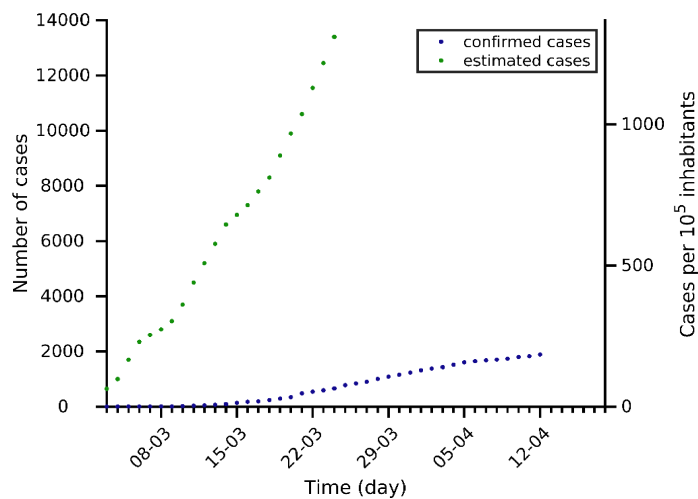
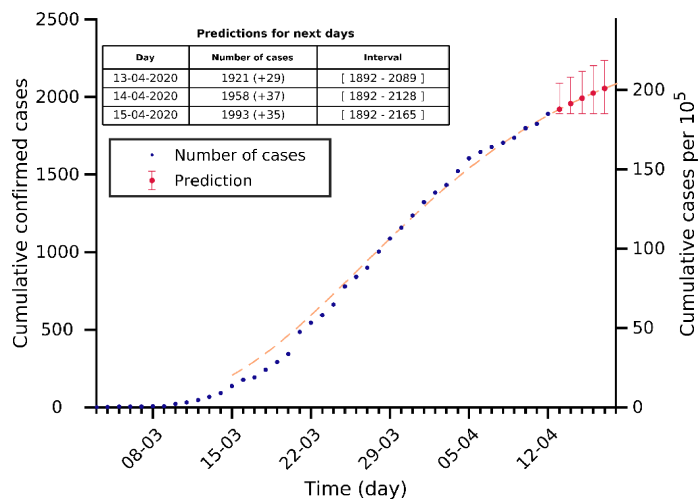
Extremadura 12-04-2020. Population: 1.1M. Current cumulated incidence: 242/10⁵



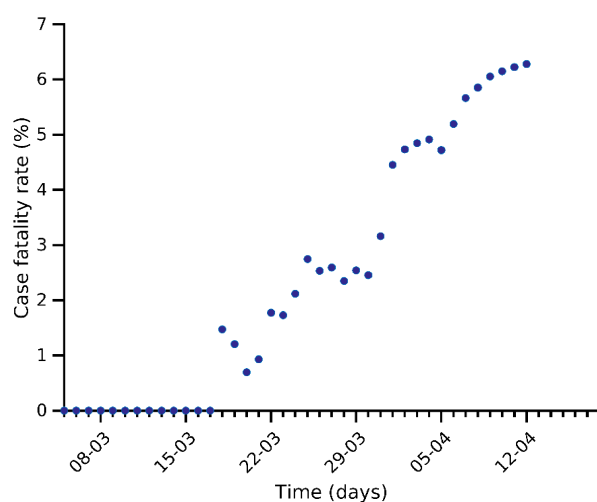
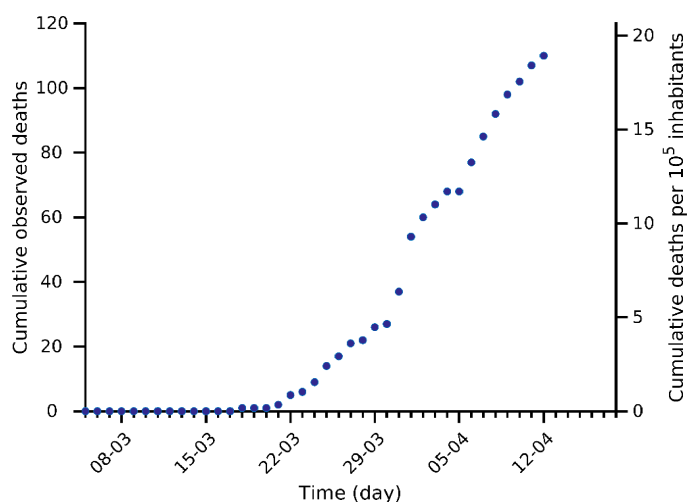
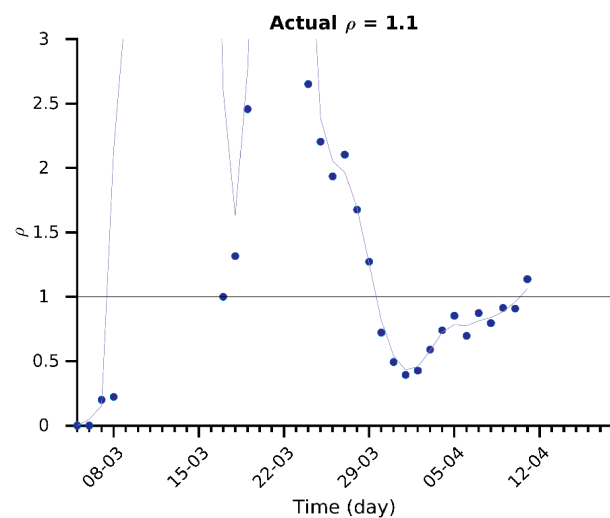
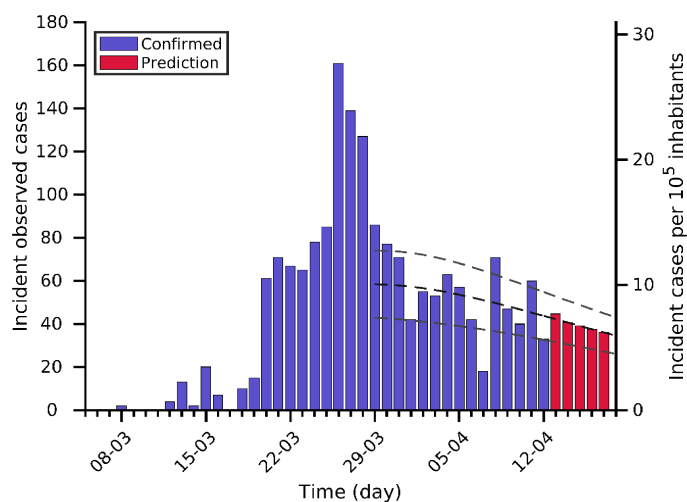
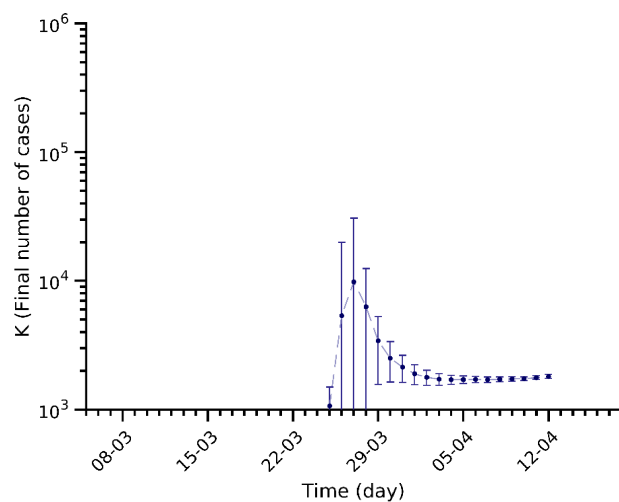
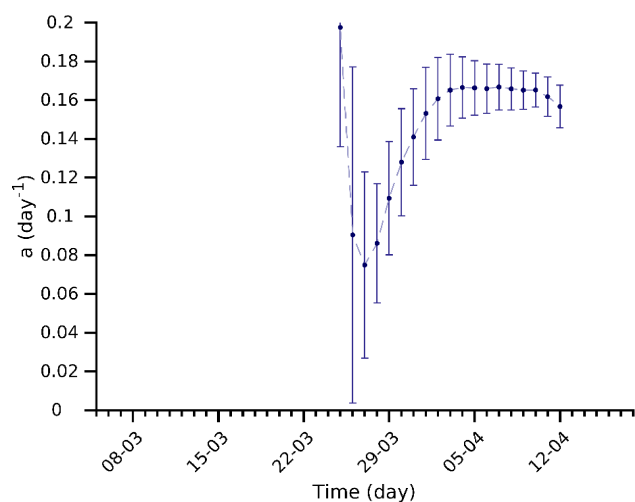
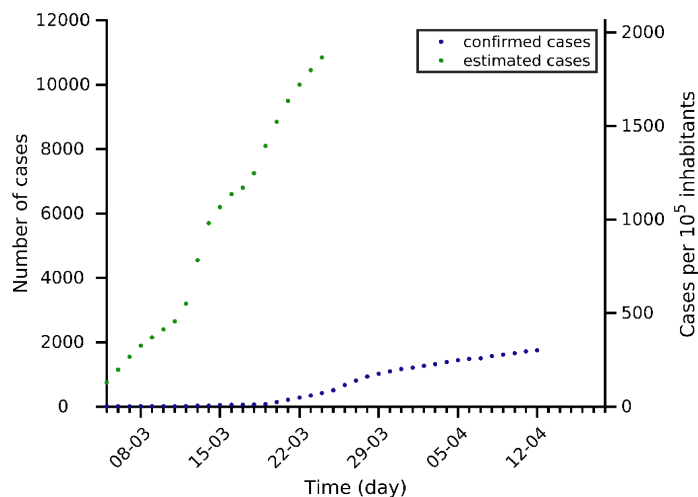
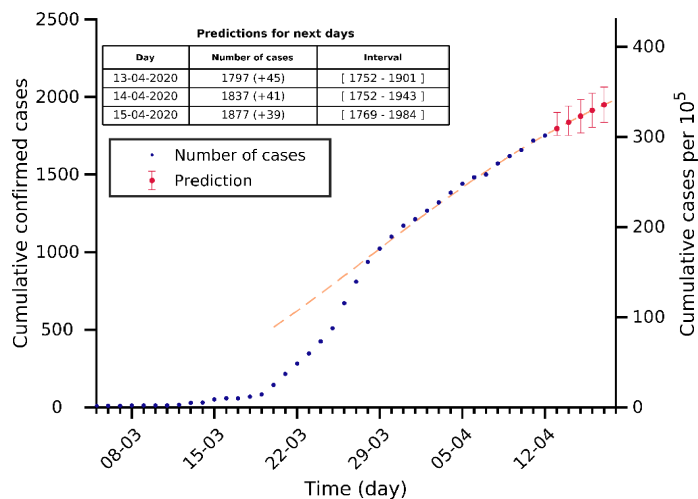
Canarias 12-04-2020. Population: 2.2M. Current cumulated incidence: 89/10⁵



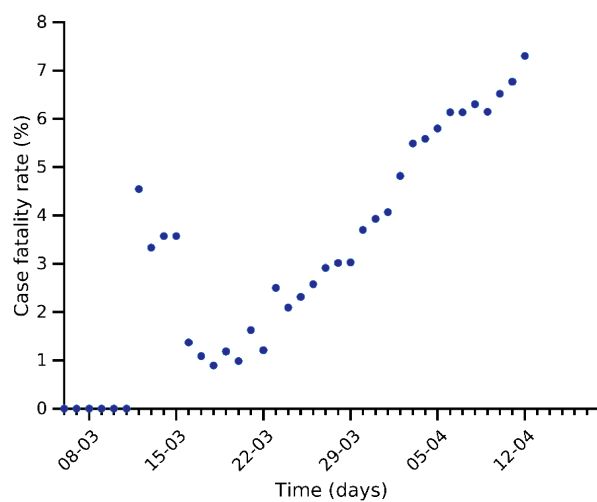
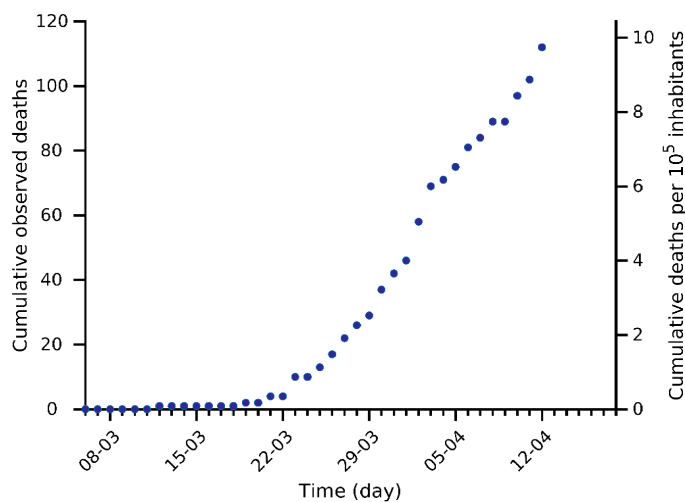
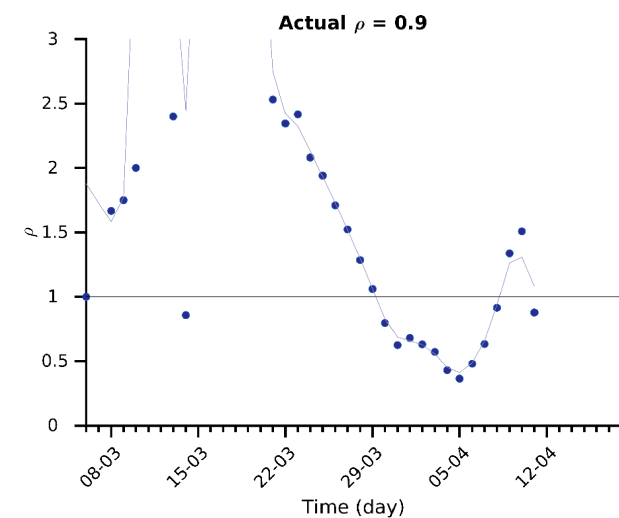
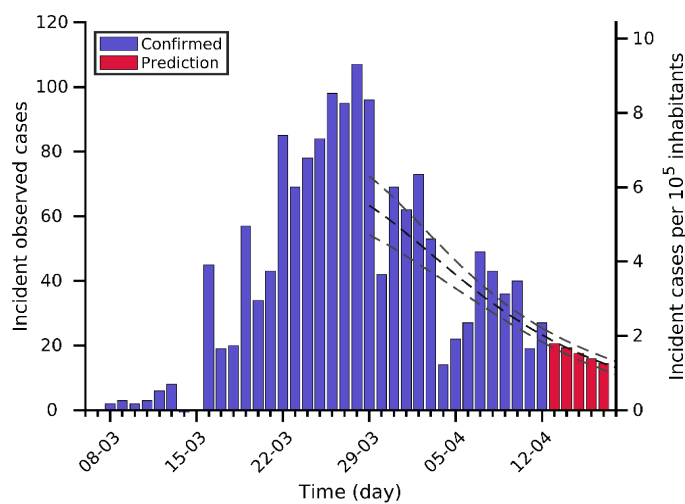
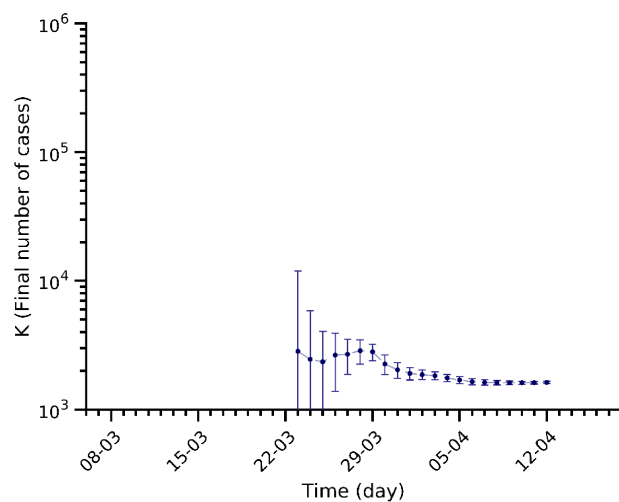
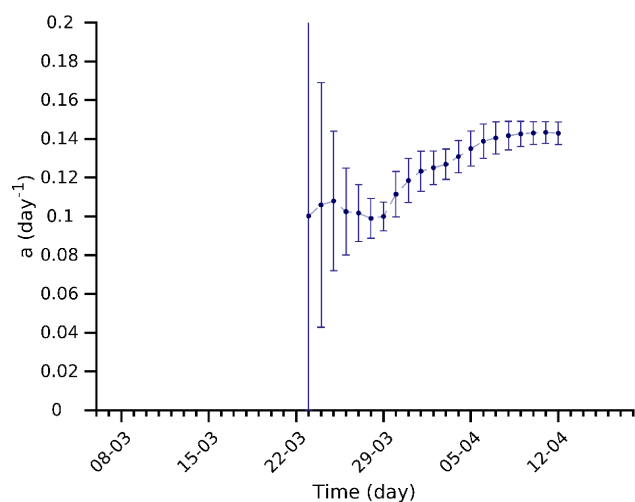
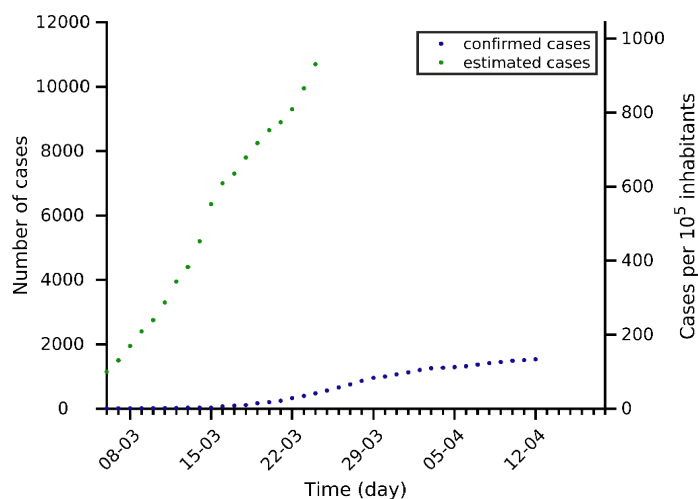
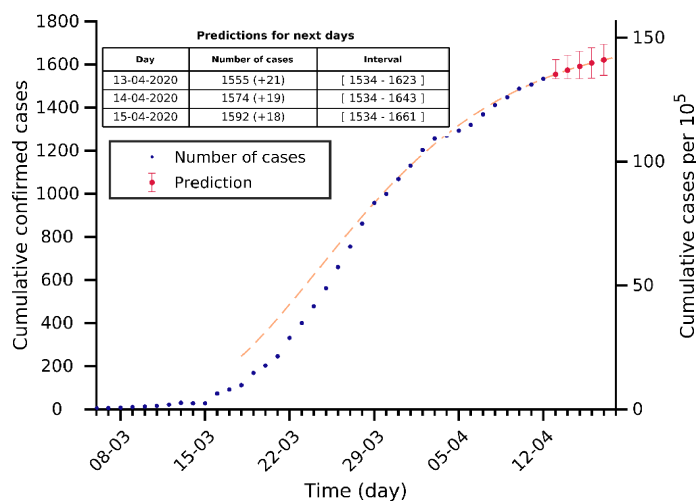
Asturias 12-04-2020. Population: 1.0M. Current cumulated incidence: 185/10⁵



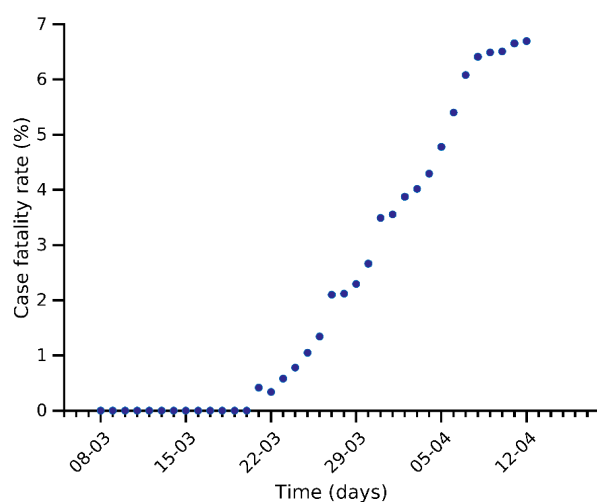
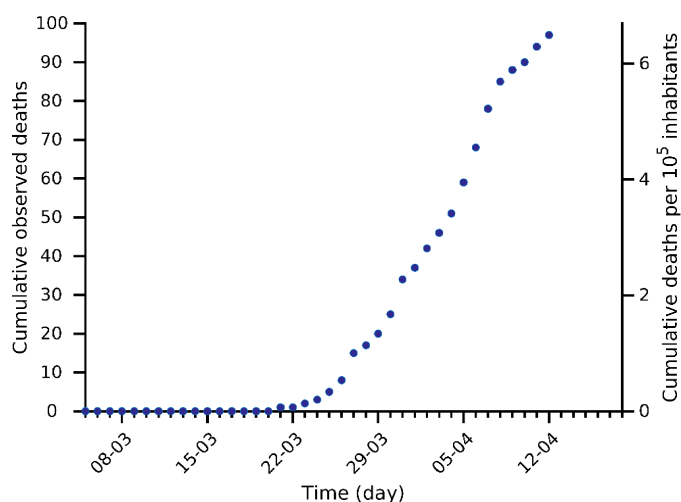
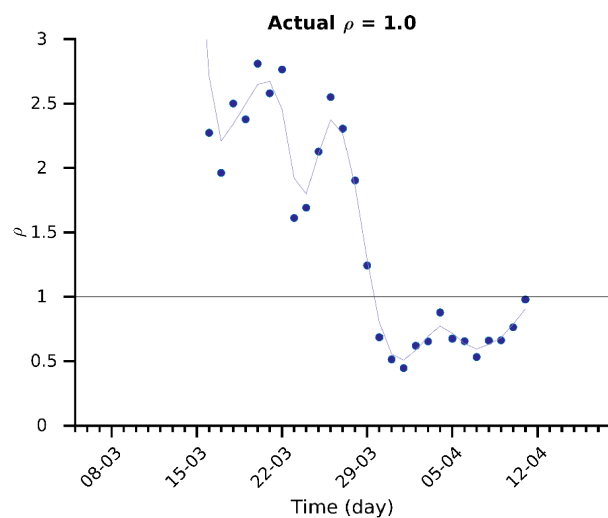
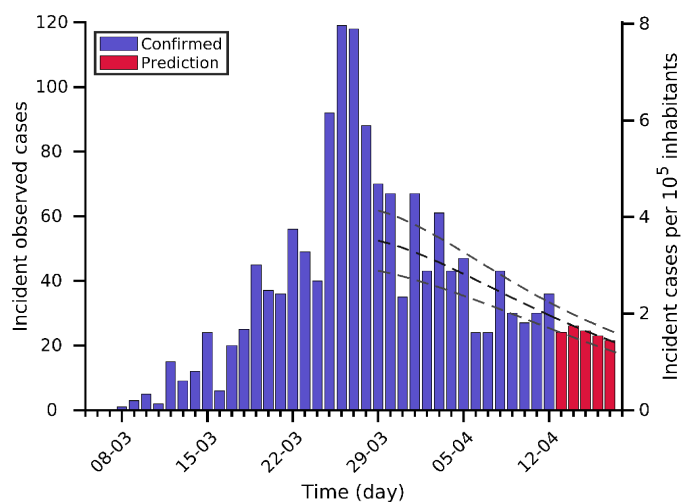
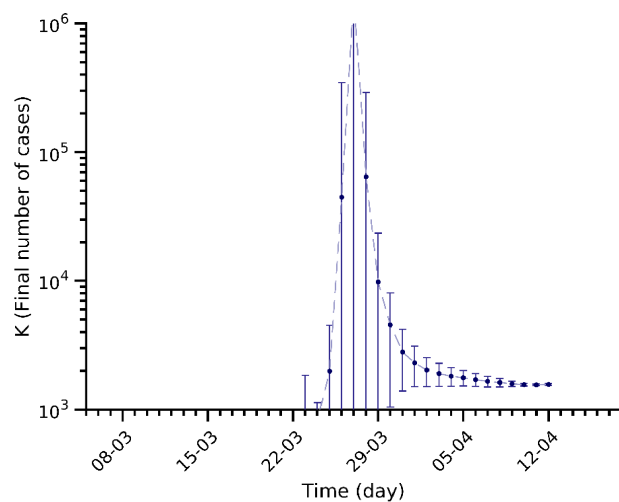
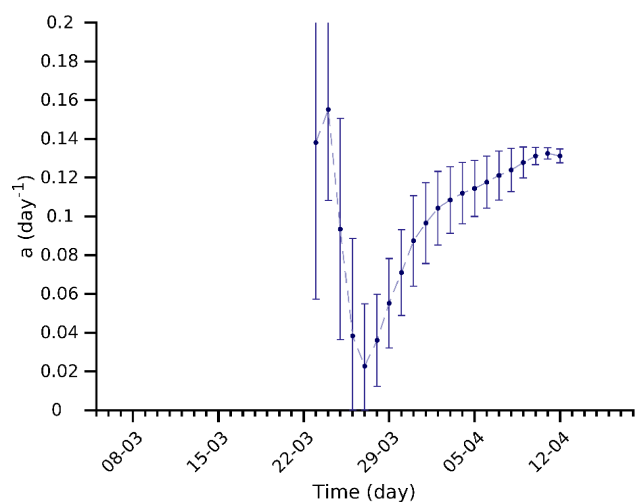
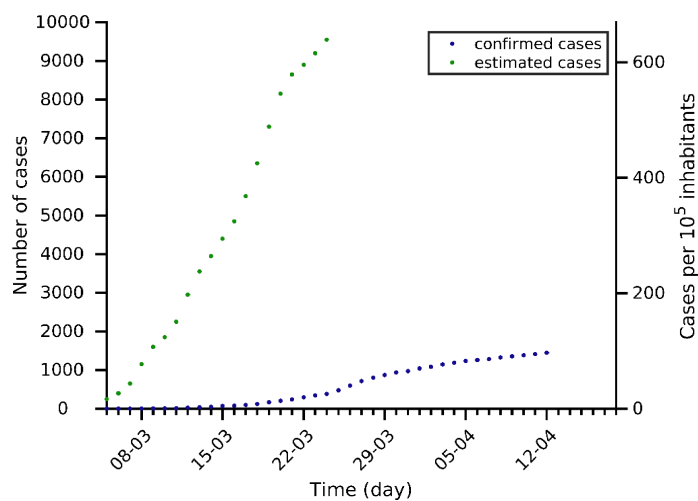
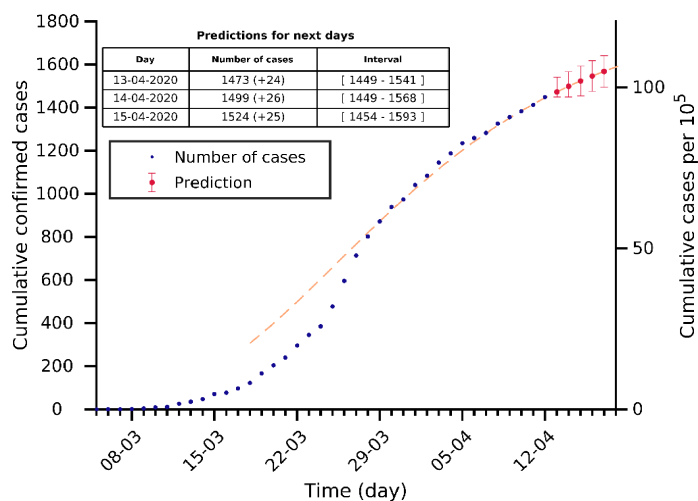
Cantabria 12-04-2020. Population: 0.6M. Current cumulated incidence: 302/10⁵



Baleares 12-04-2020. Population: 1.1M. Current cumulated incidence: 133/10⁵



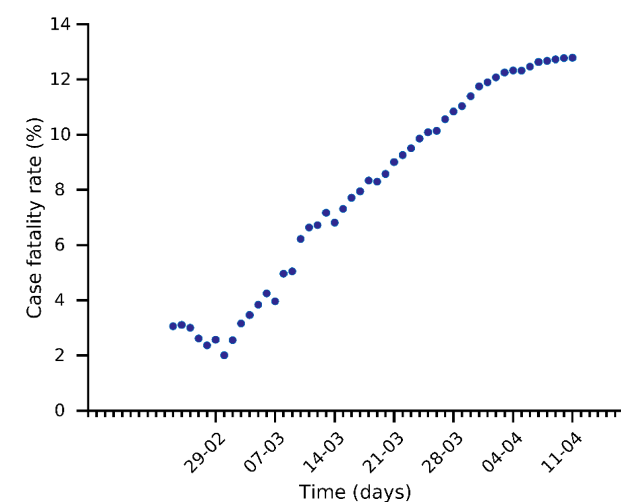
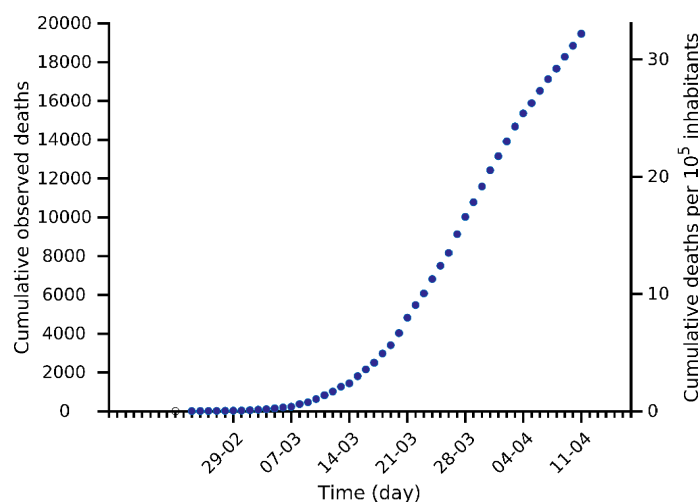
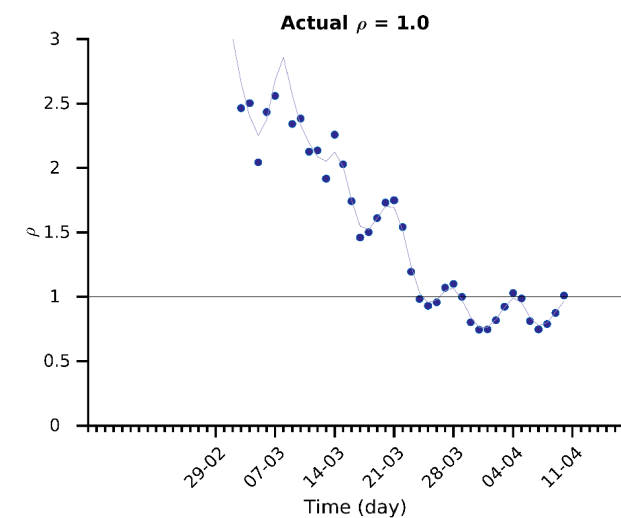
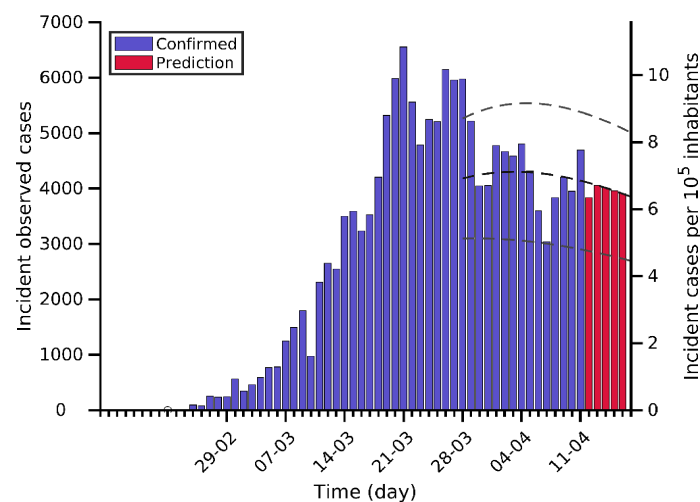
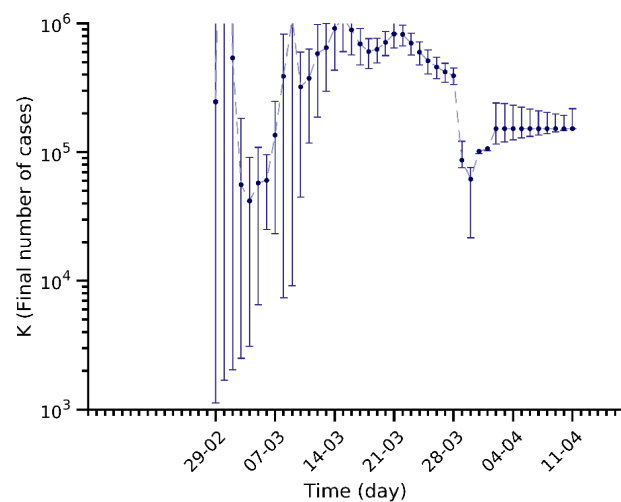
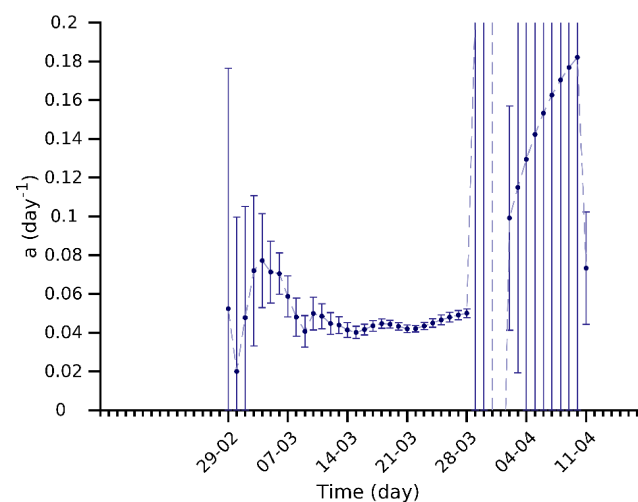
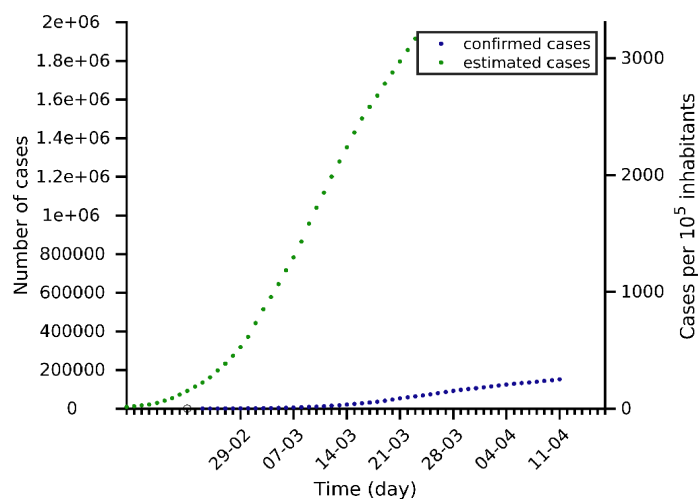
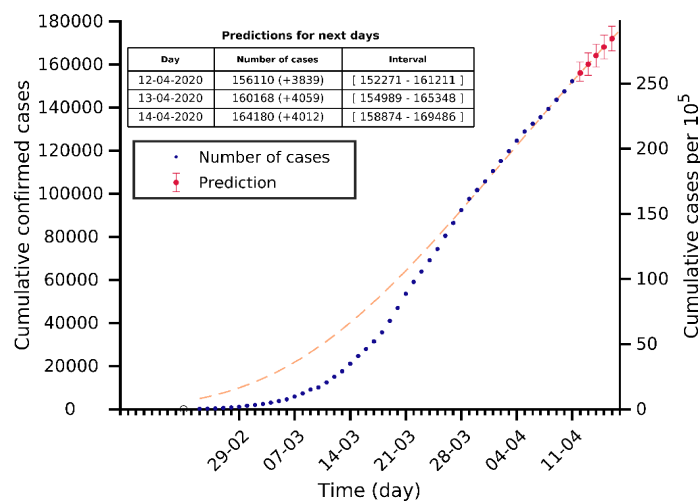
Murcia 12-04-2020. Population: 1.5M. Current cumulated incidence: 97/10⁵



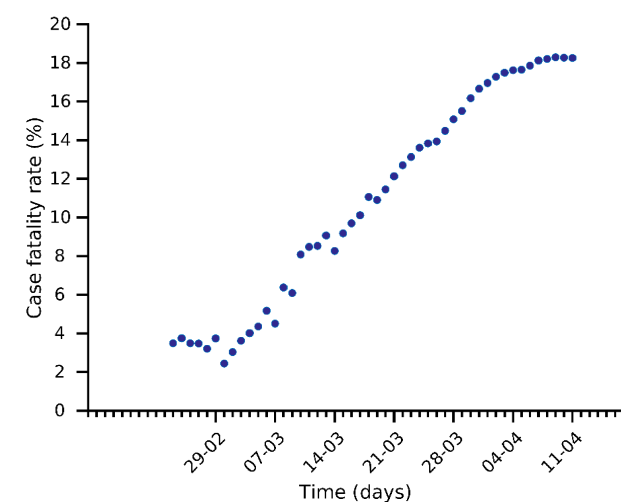
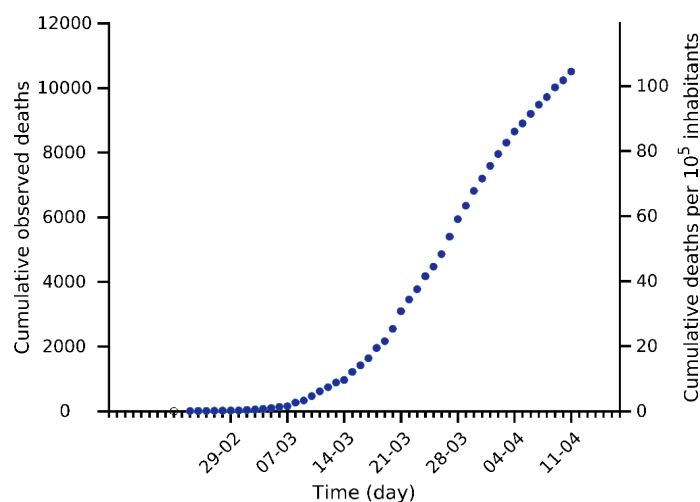
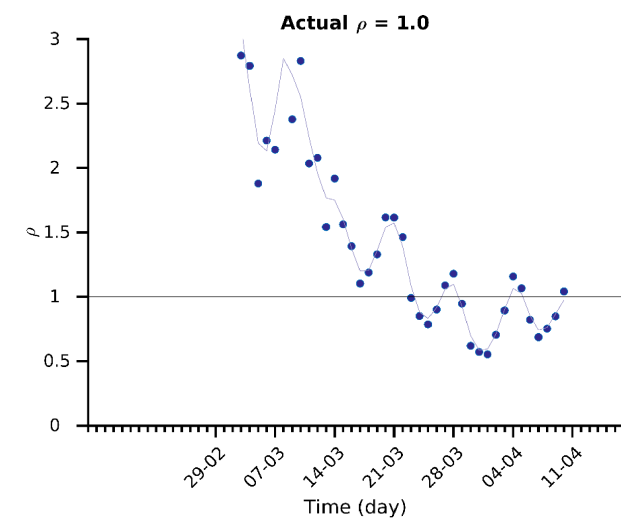
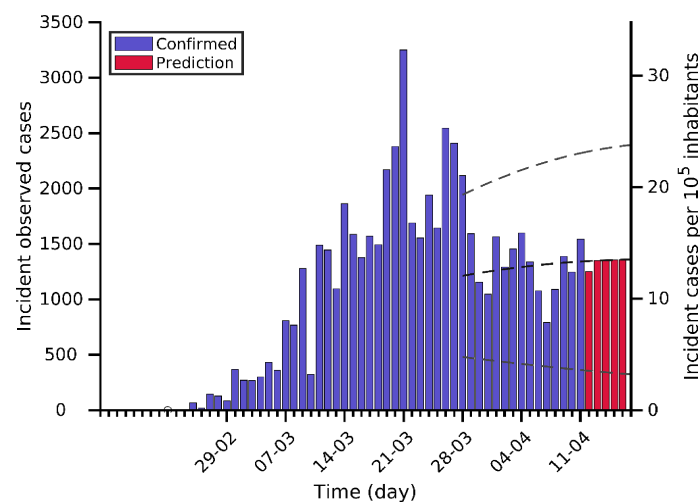
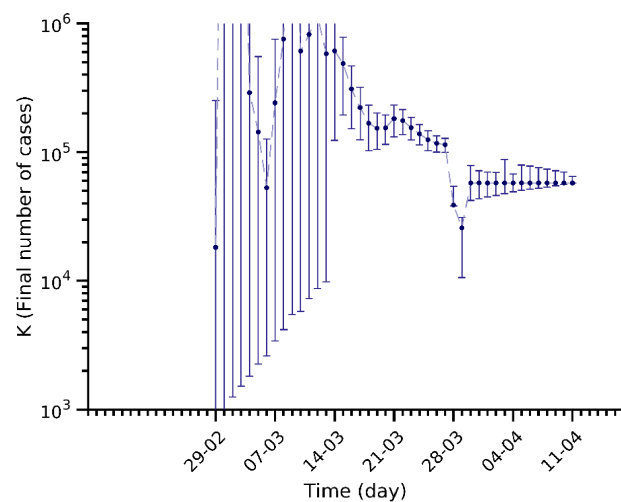
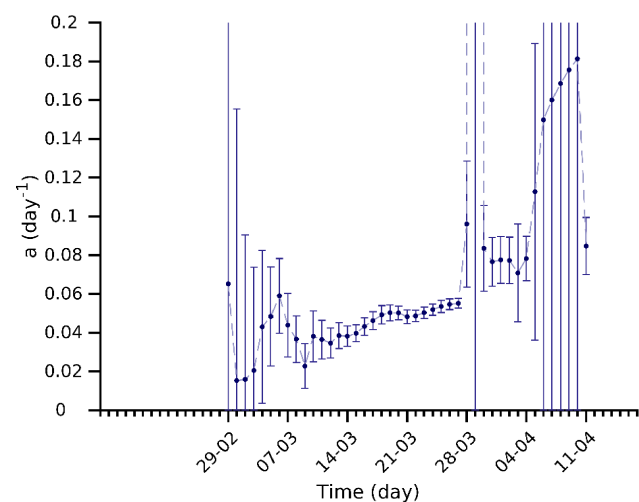
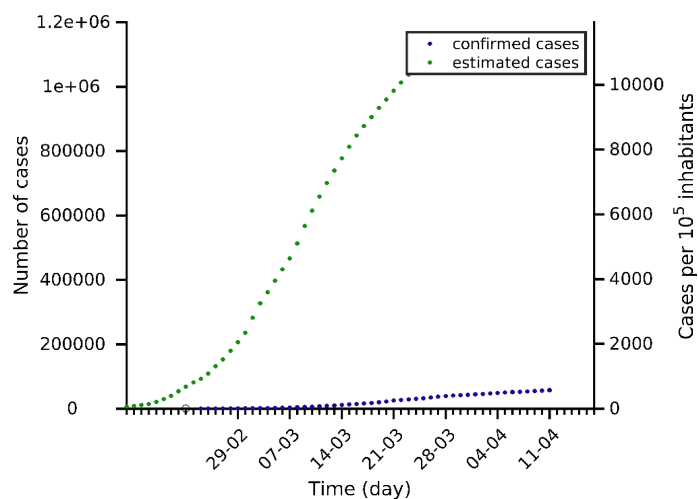
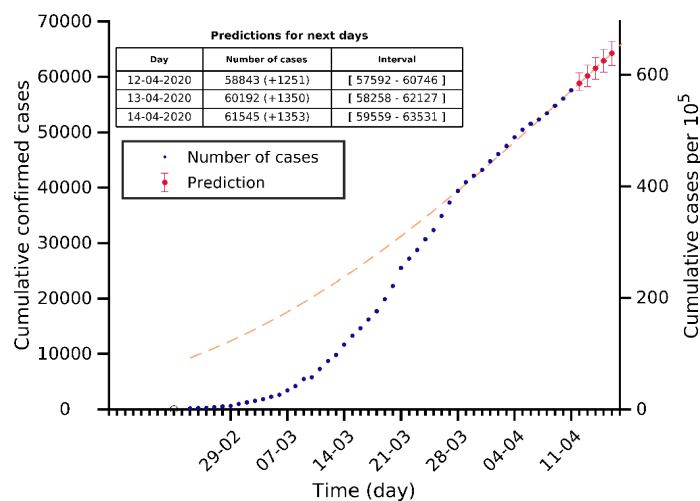
(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

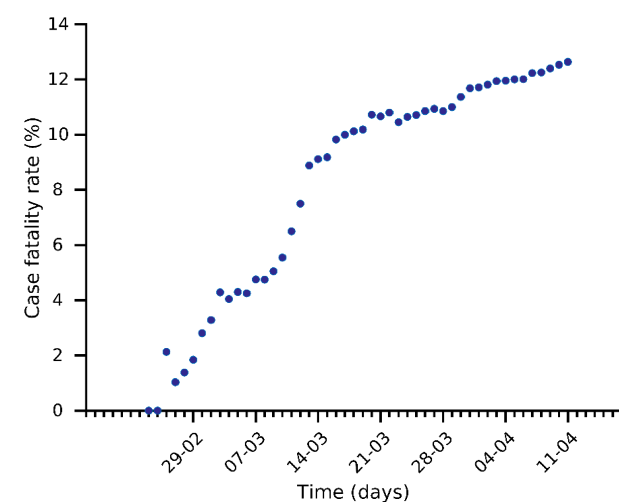
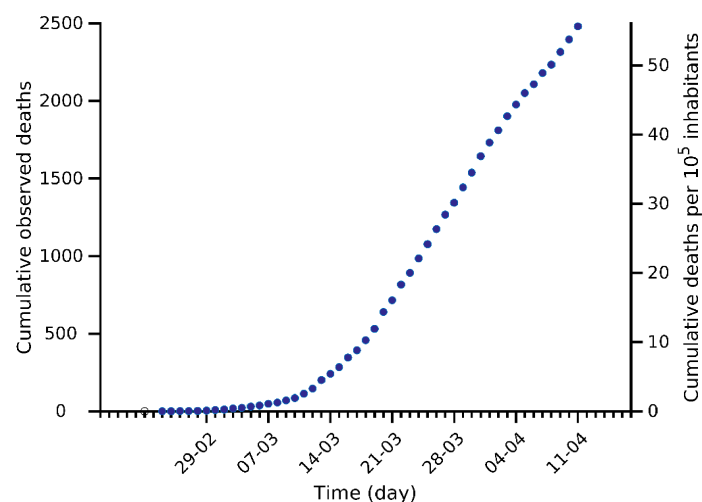
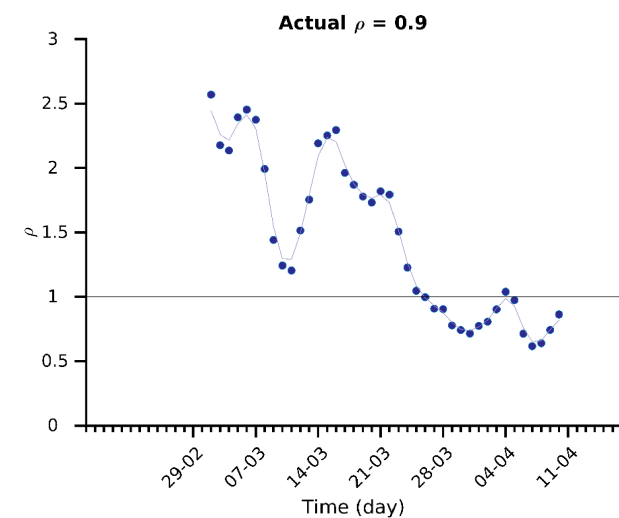
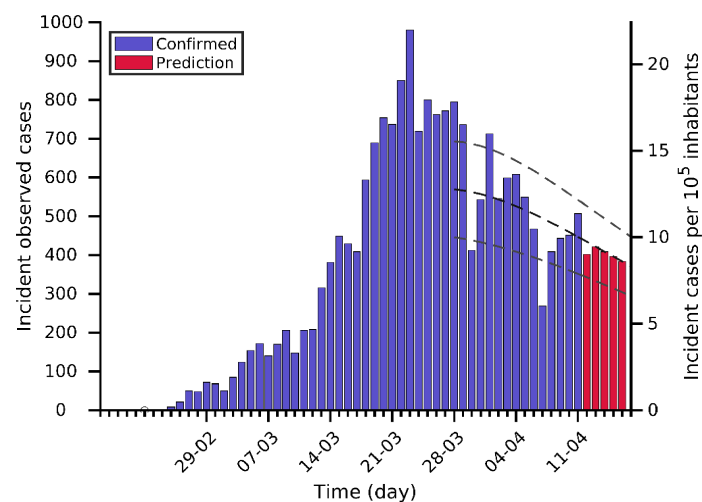
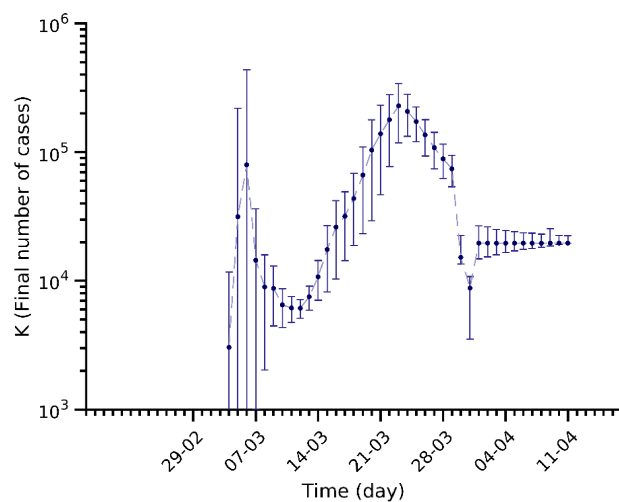
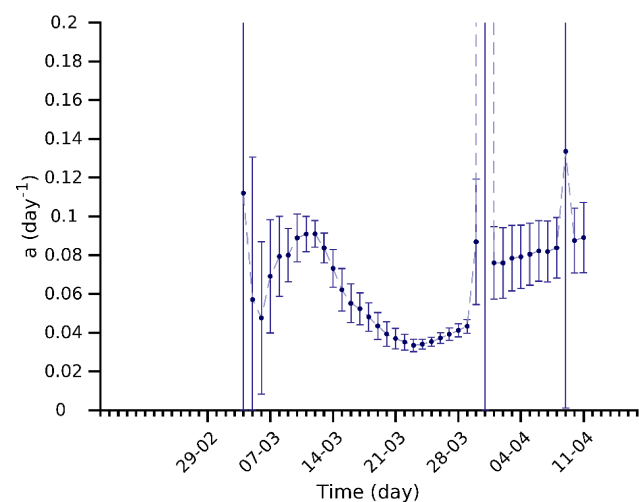
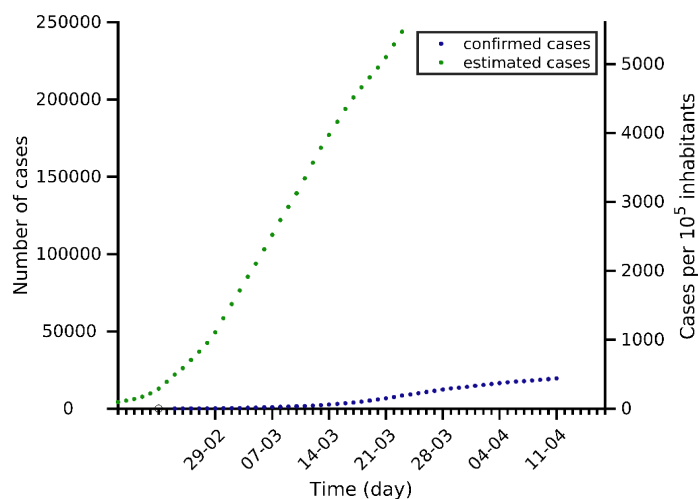
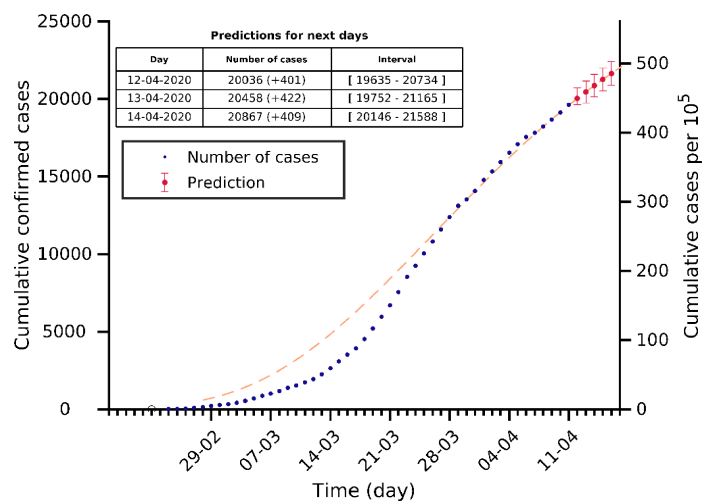
Italy 11-04-2020. Population: 60.5M. Current cumulated incidence: 252/10⁵



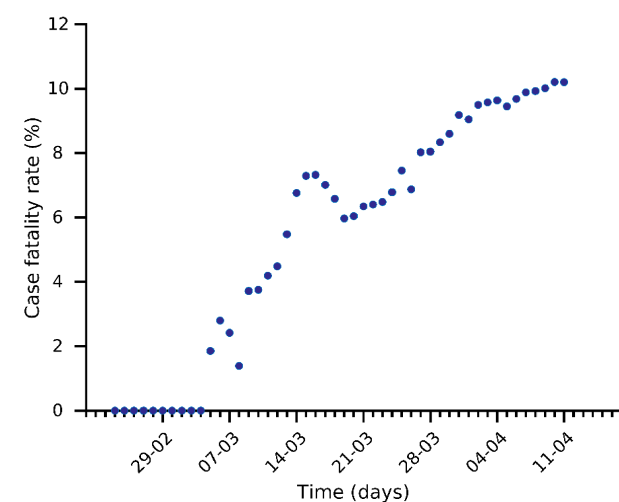
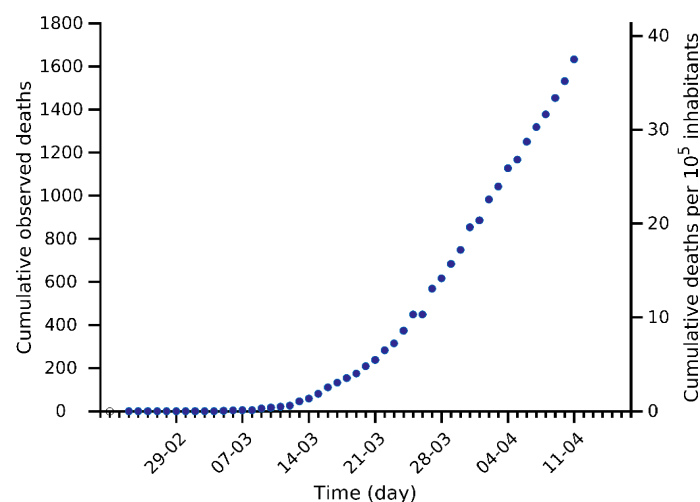
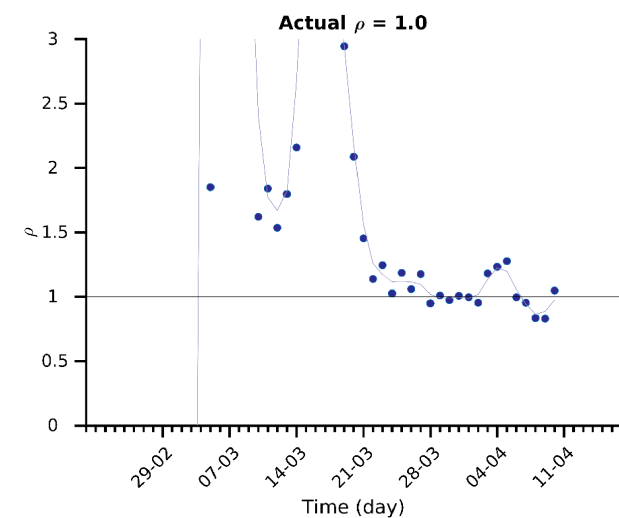
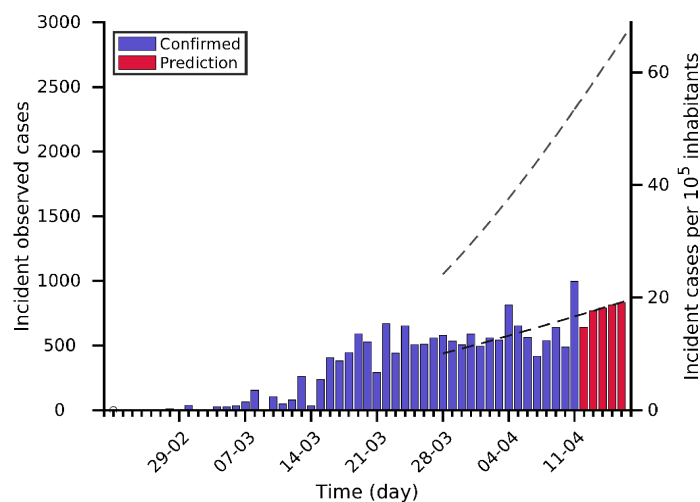
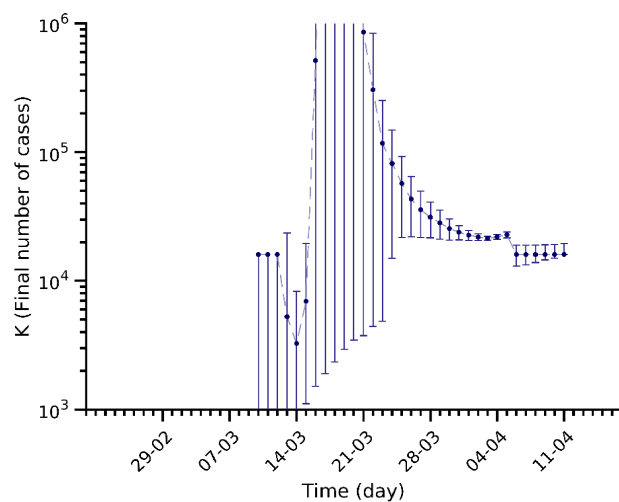
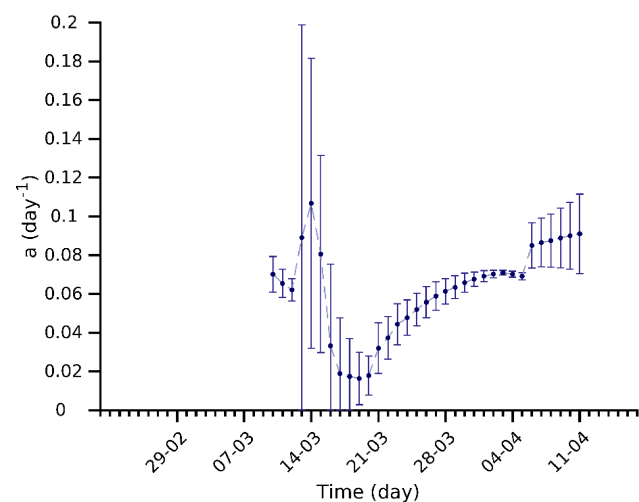
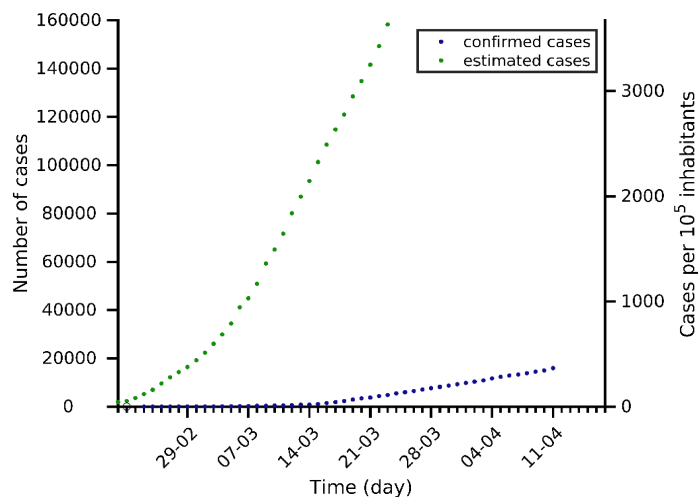
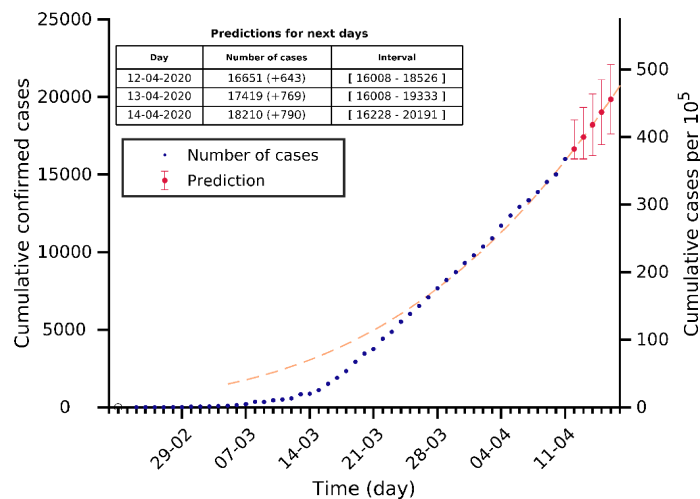
Lombardia 11-04-2020. Population: 10.1M. Current cumulated incidence: 572/10⁵



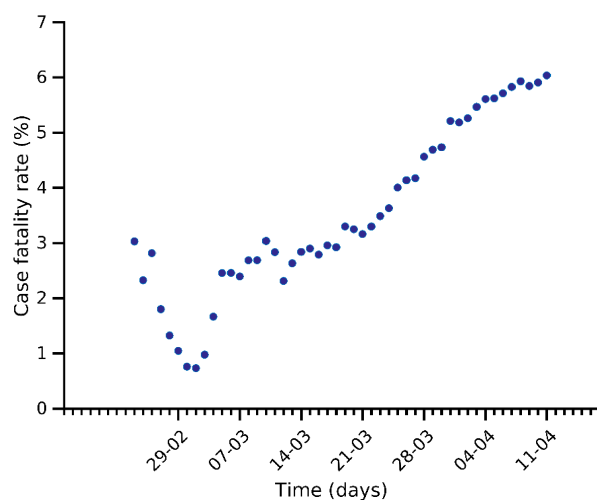
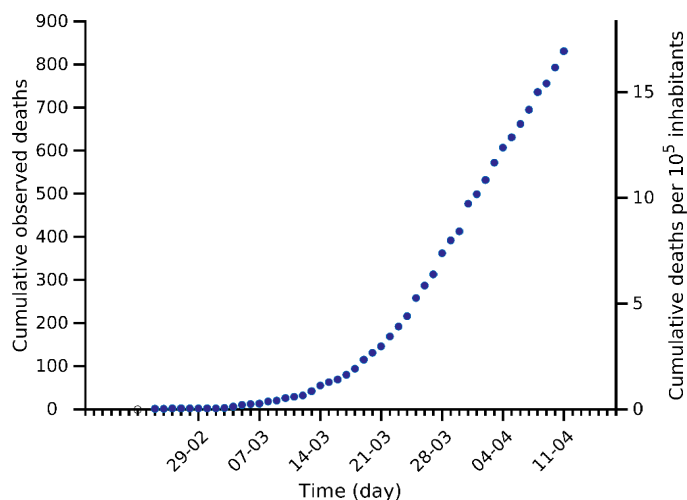
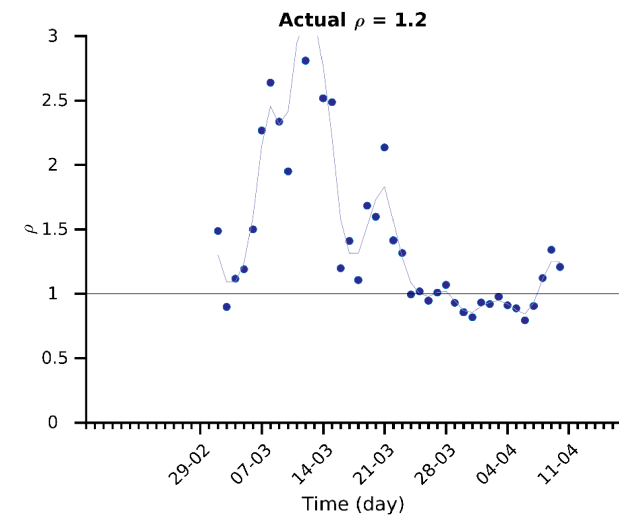
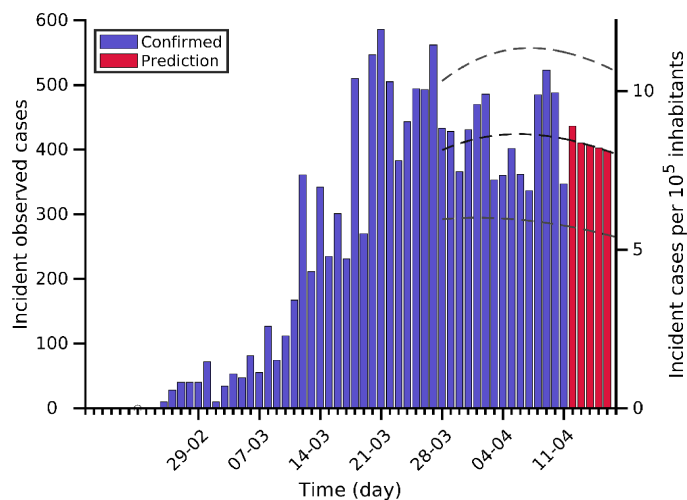
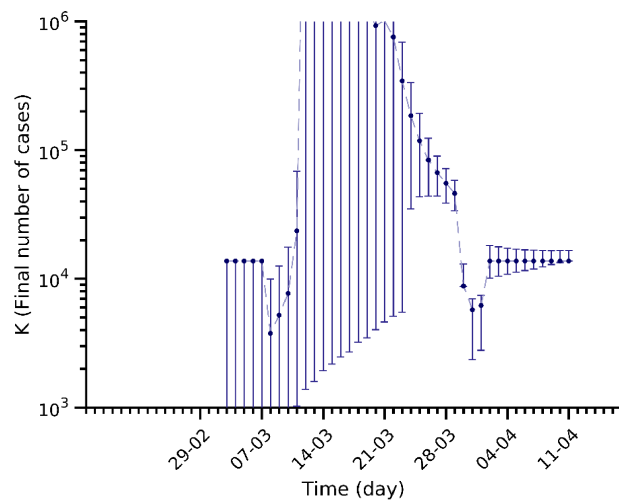
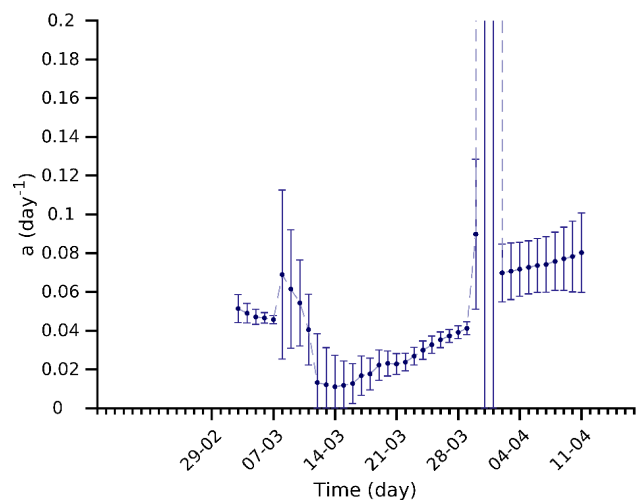
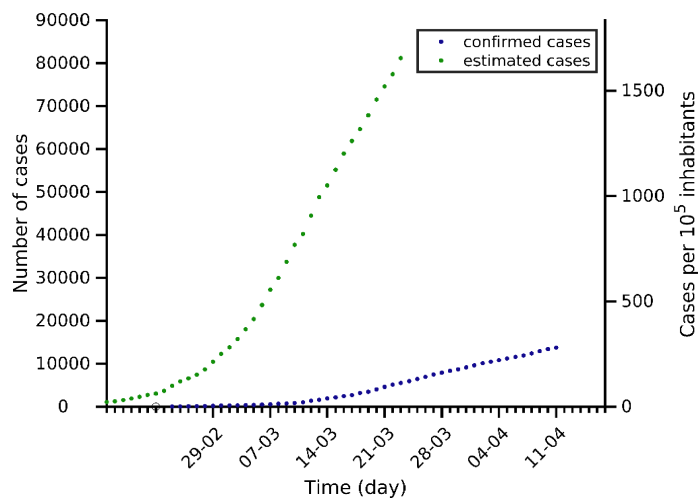
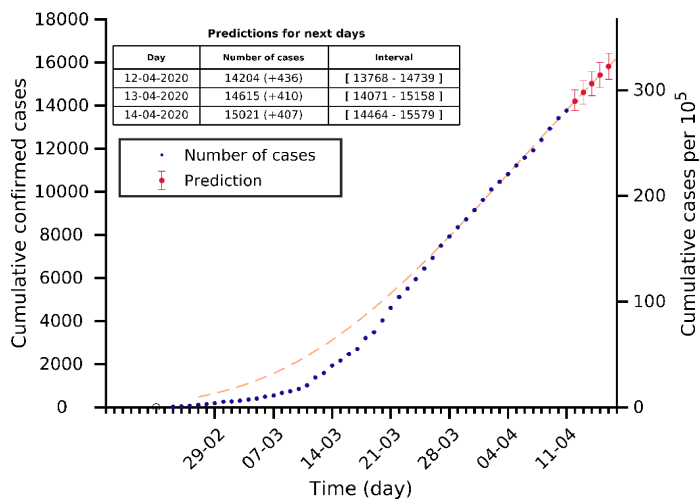
Emilia Romagna 11-04-2020. Population: 4.5M. Current cumulated incidence: 440/10⁵



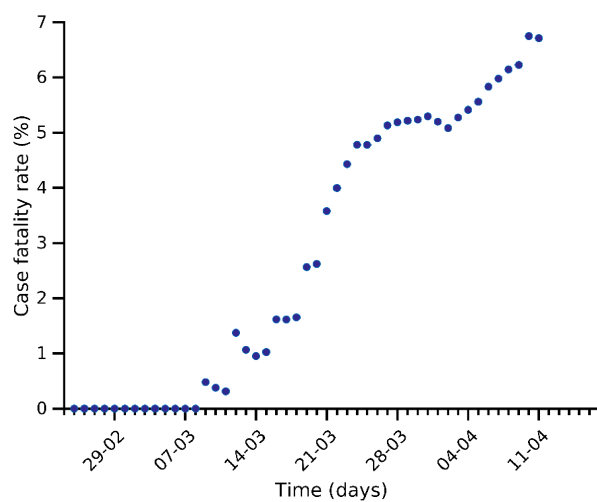
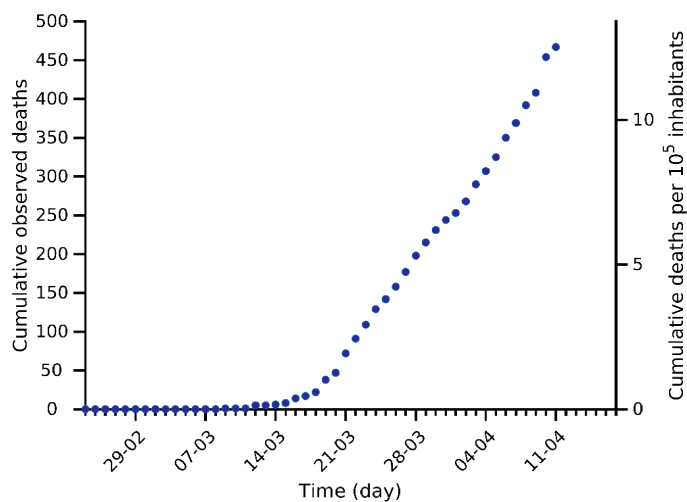
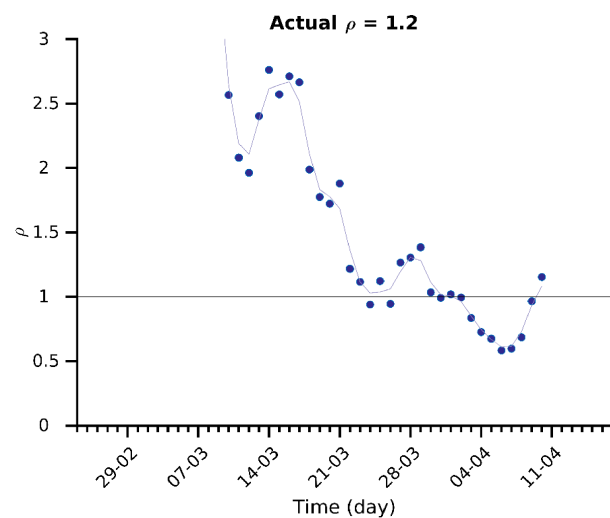
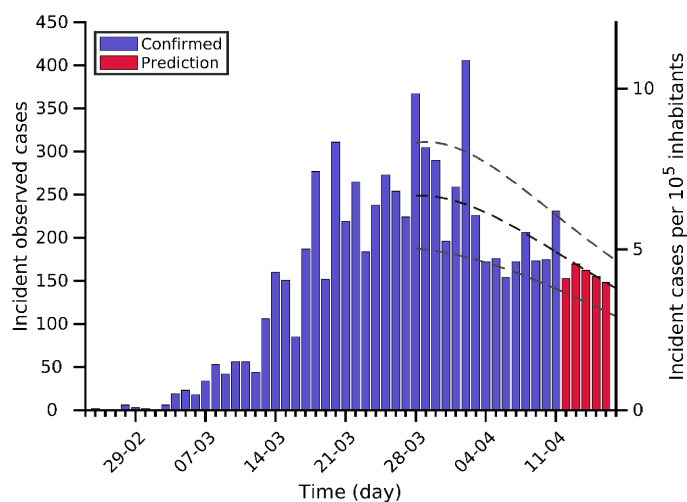
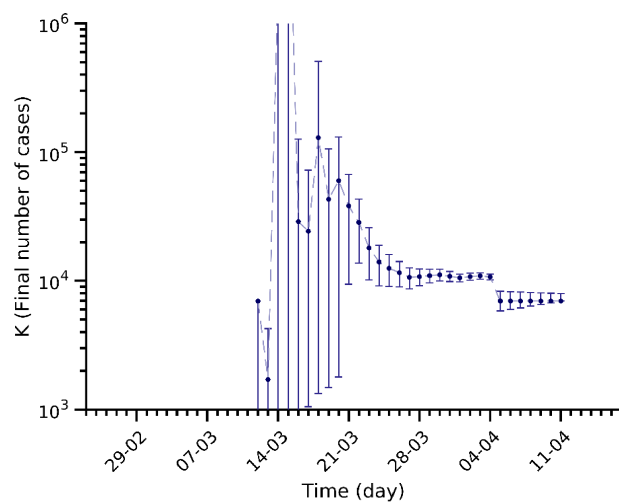
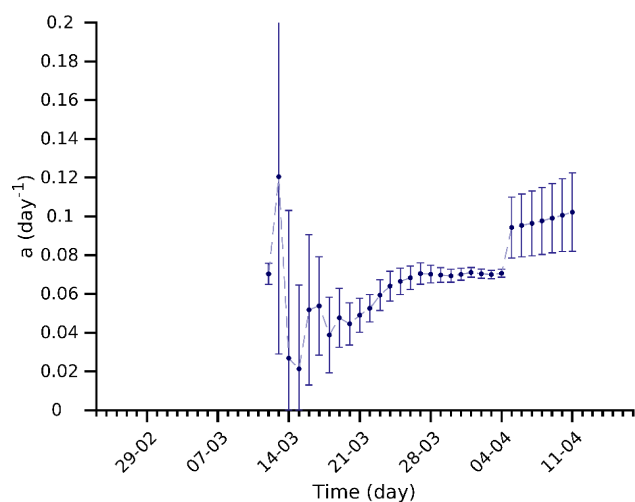
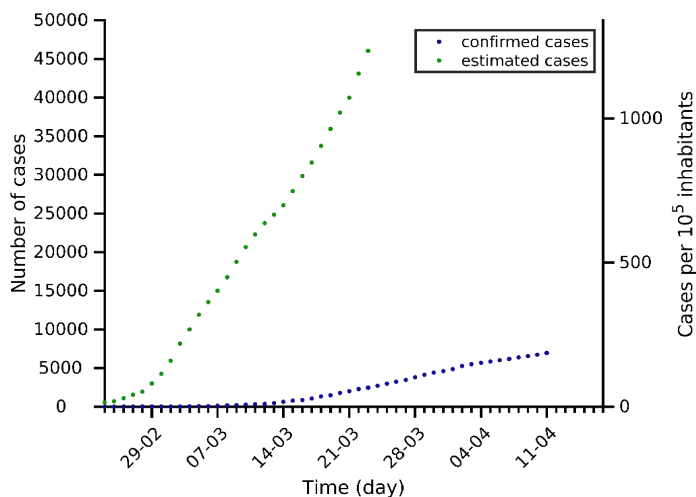
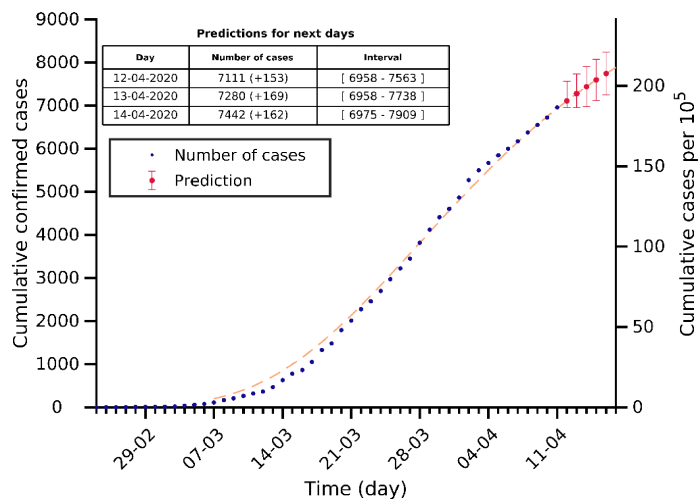
Piemonte 11-04-2020. Population: 4.4M. Current cumulated incidence: 367/10⁵



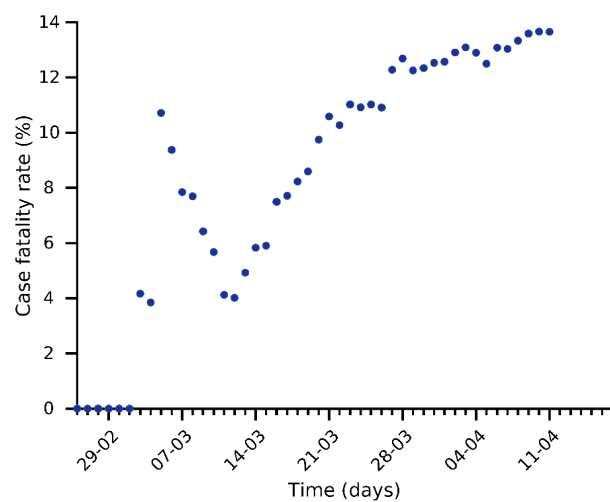
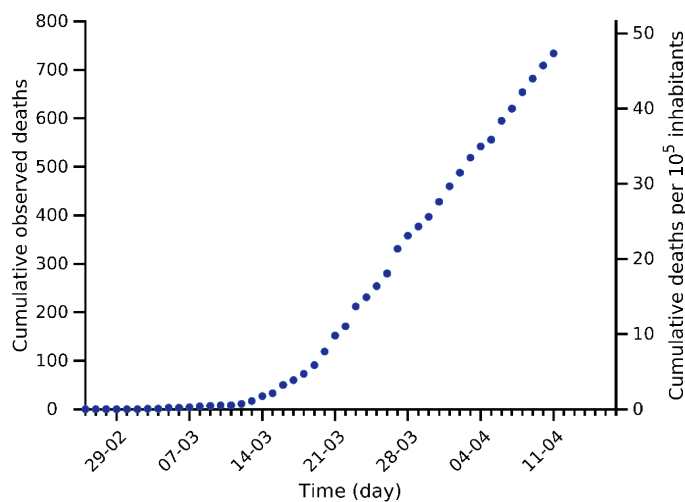
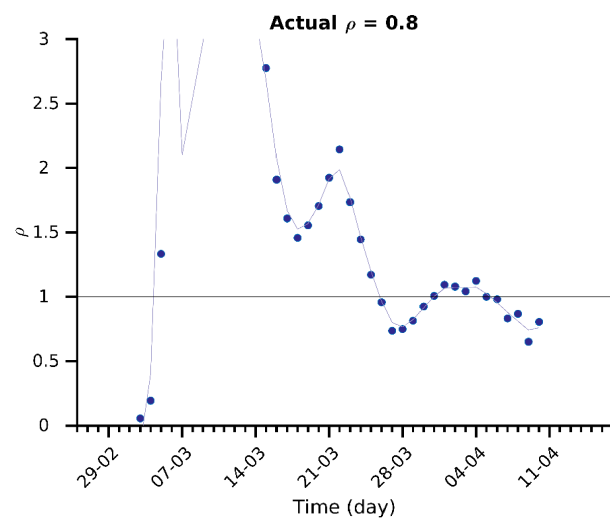
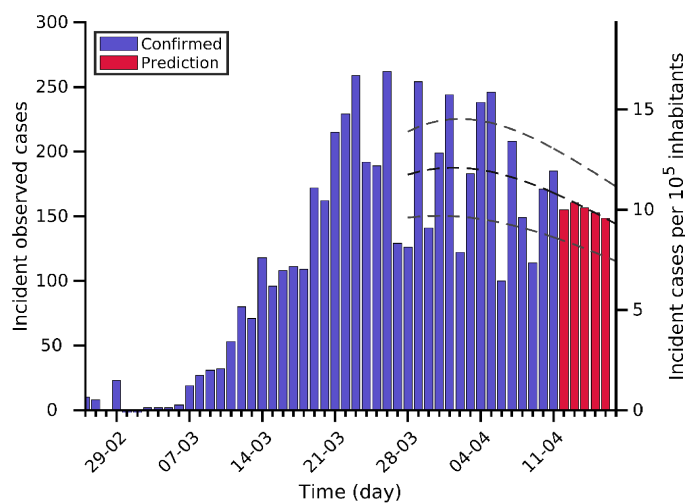
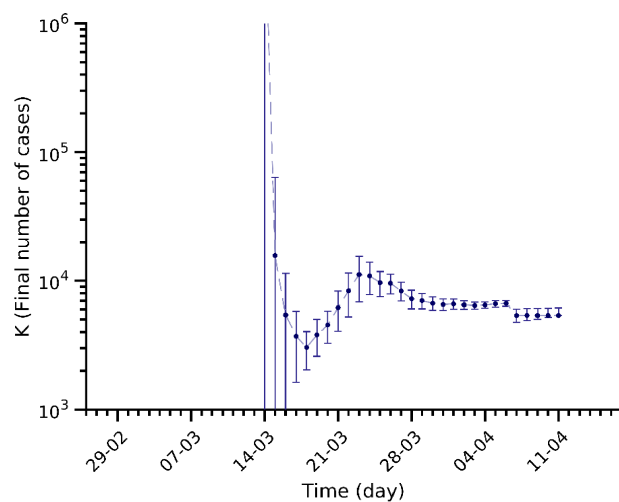
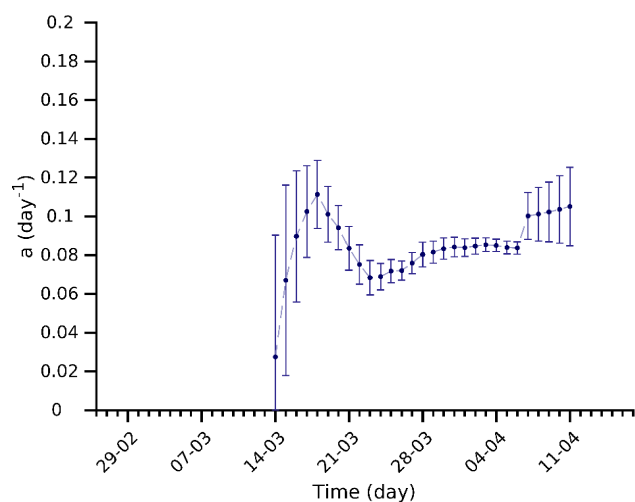
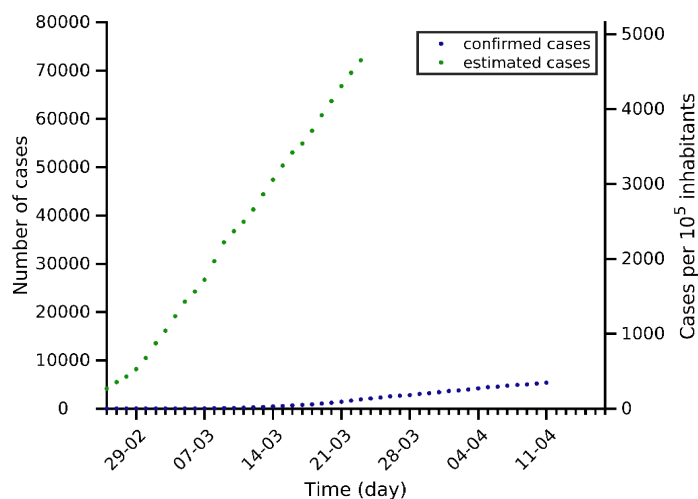
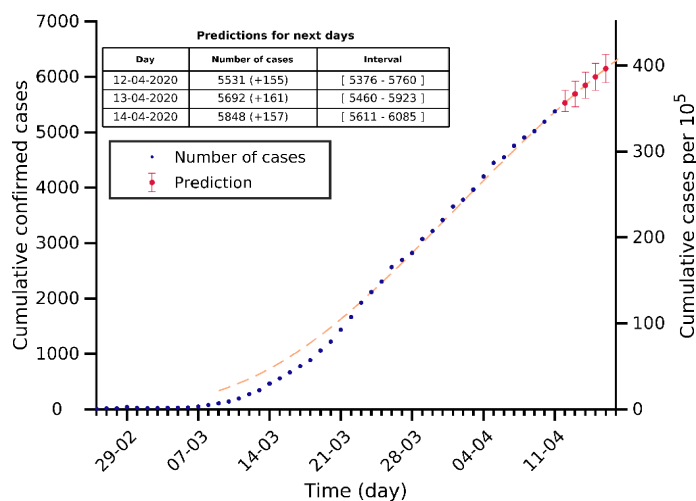
Veneto 11-04-2020. Population: 4.9M. Current cumulated incidence: 281/10⁵



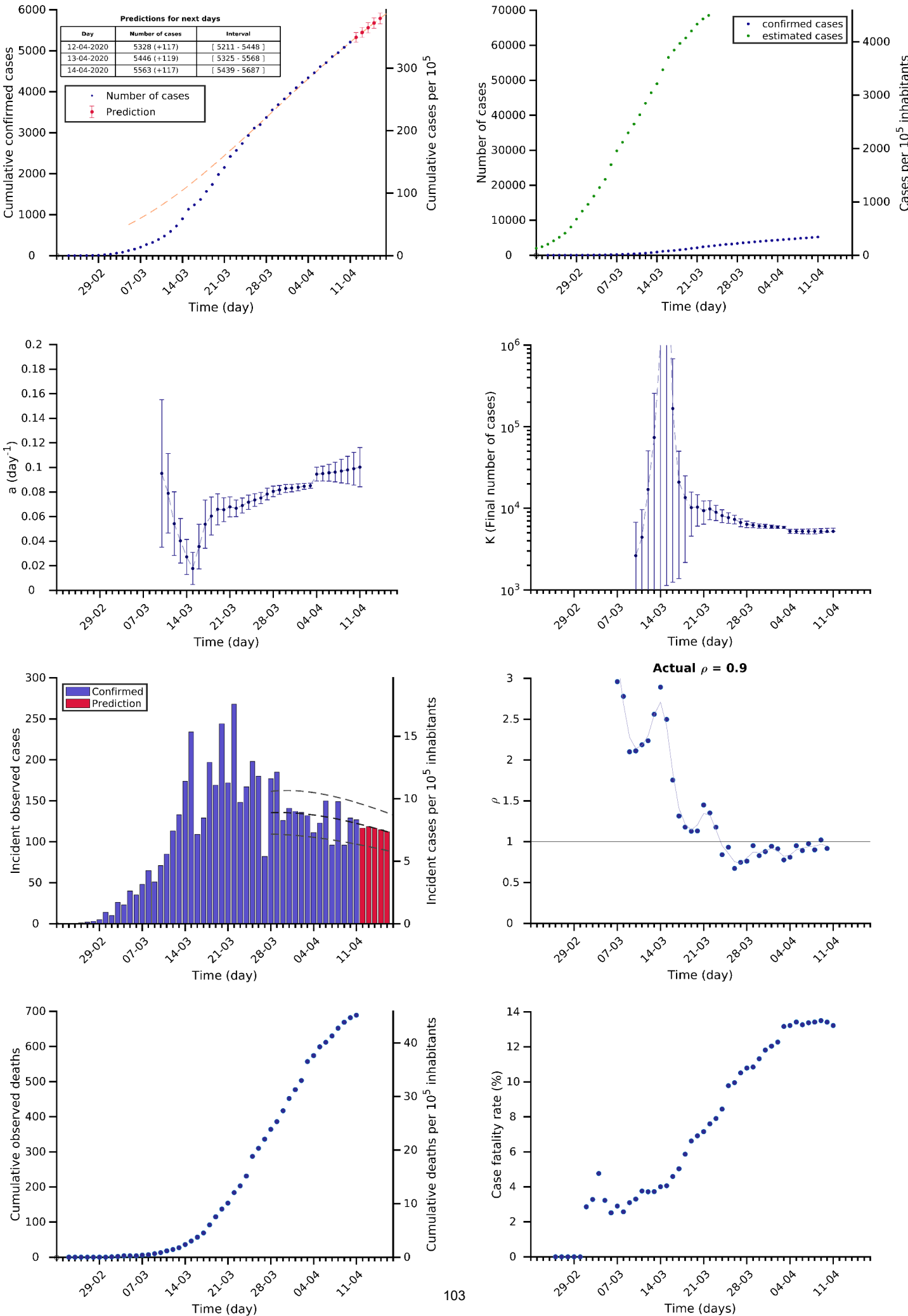
Toscana 11-04-2020. Population: 3.7M. Current cumulated incidence: 187/10⁵



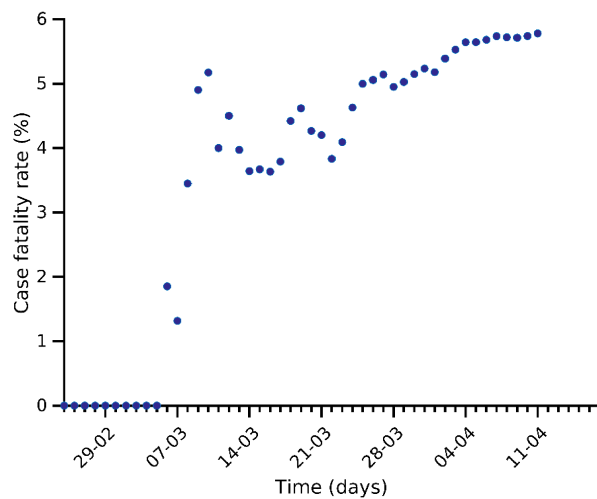
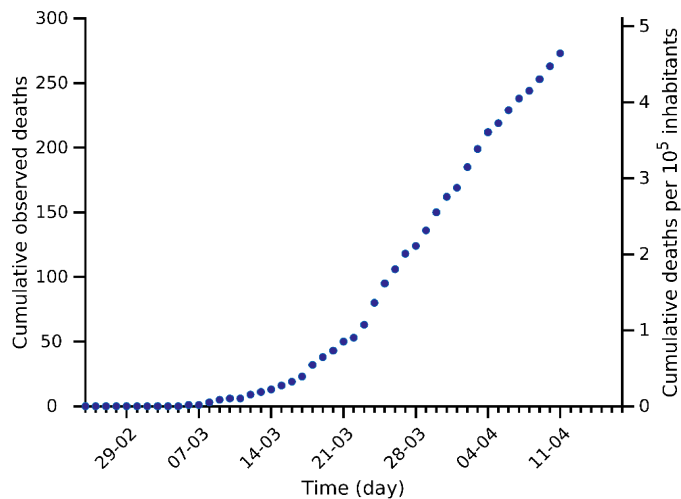
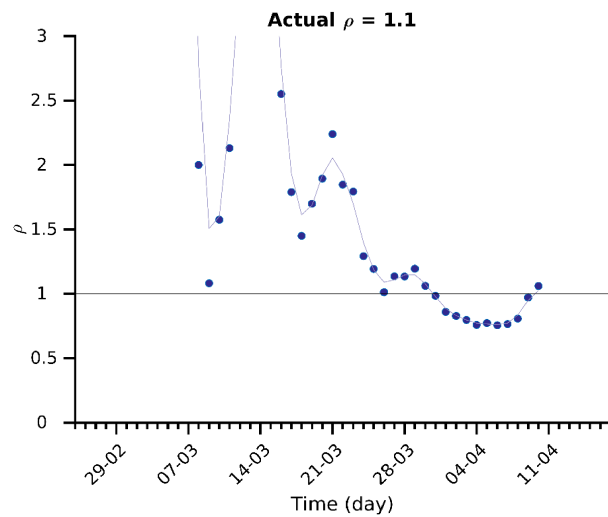
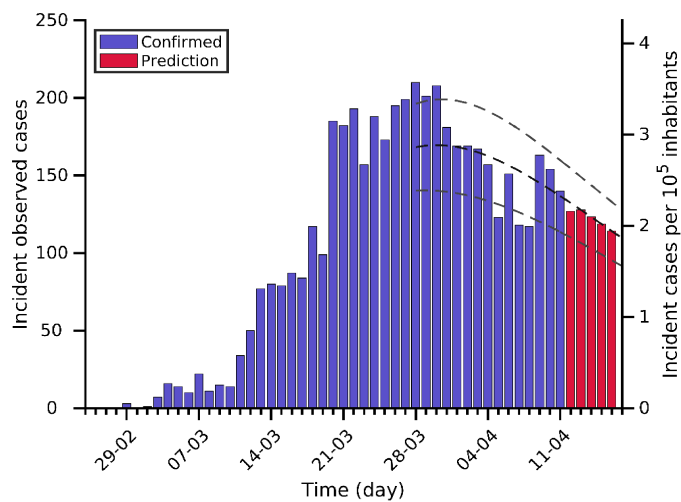
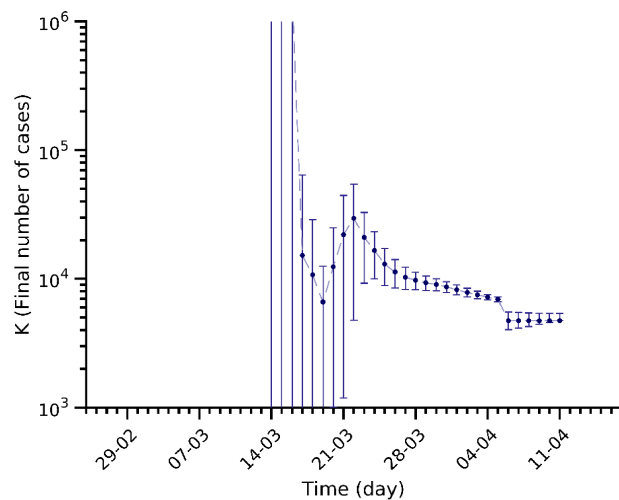
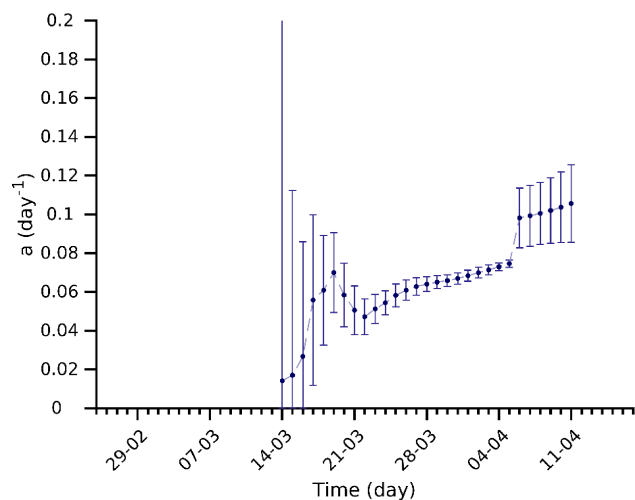
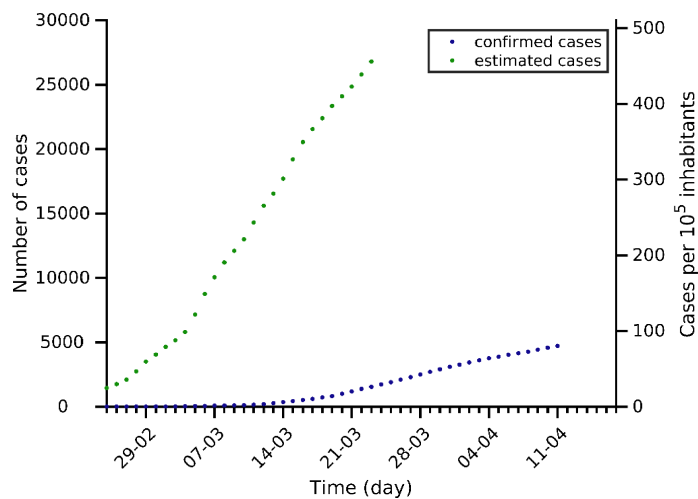
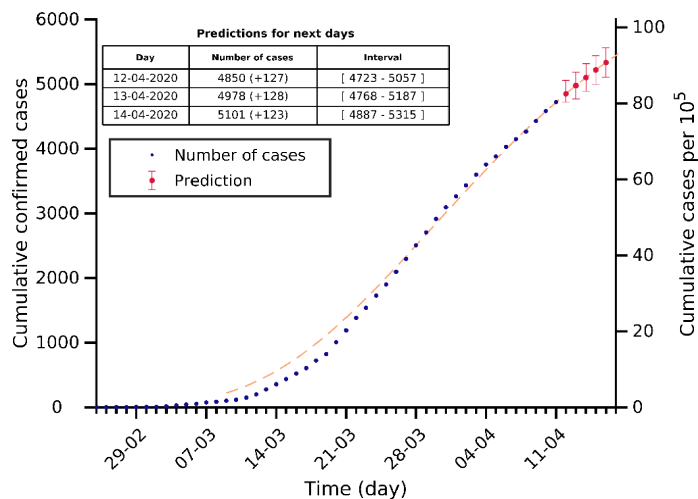
Liguria 11-04-2020. Population: 1.6M. Current cumulated incidence: 347/10⁵



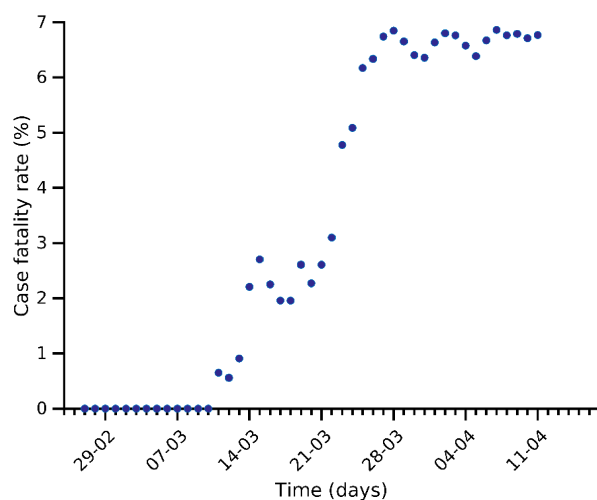
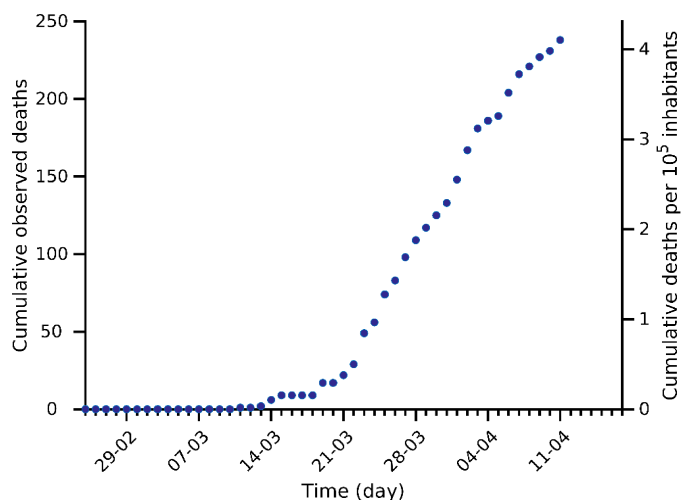
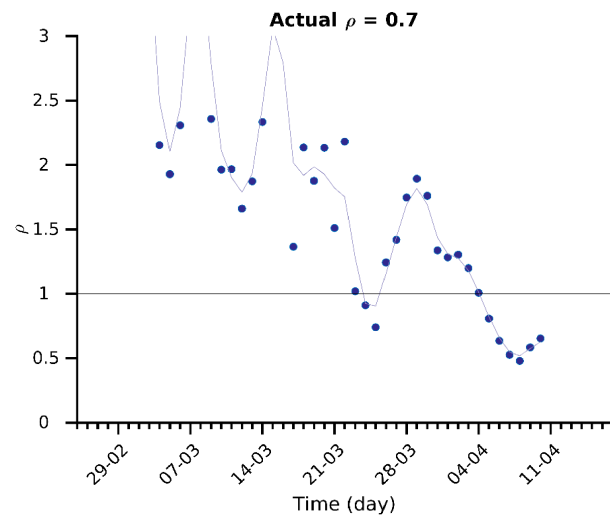
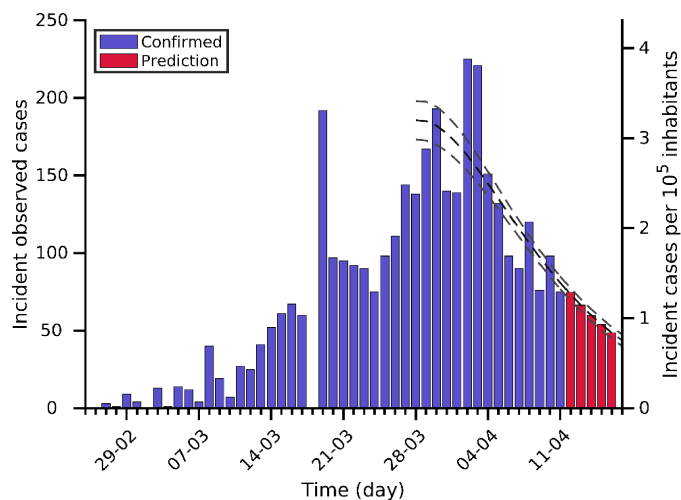
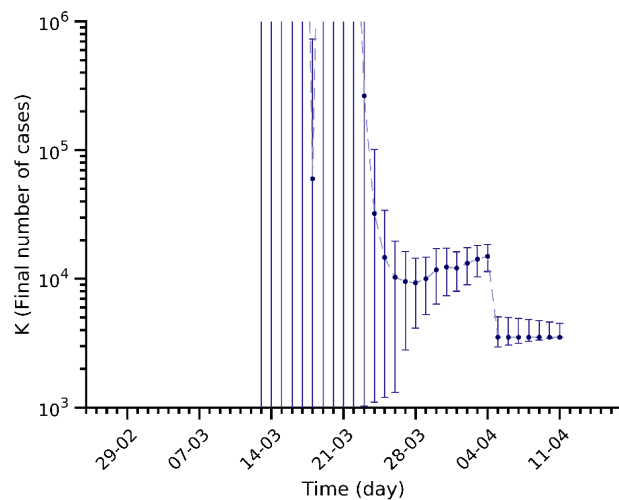
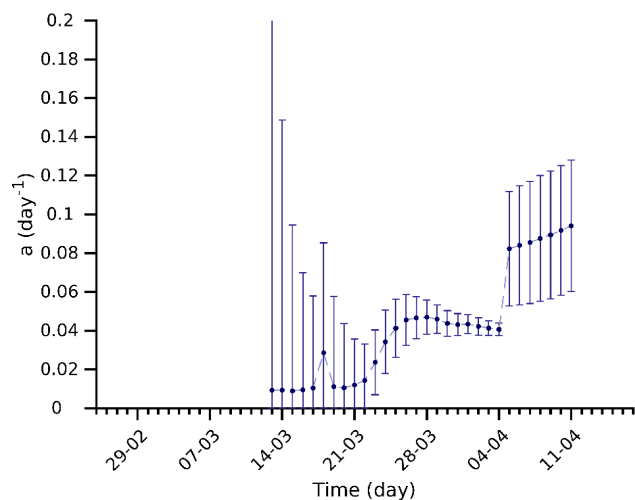
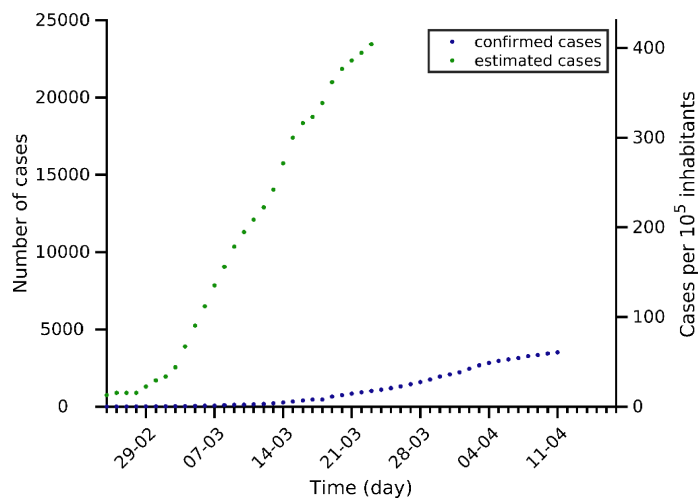
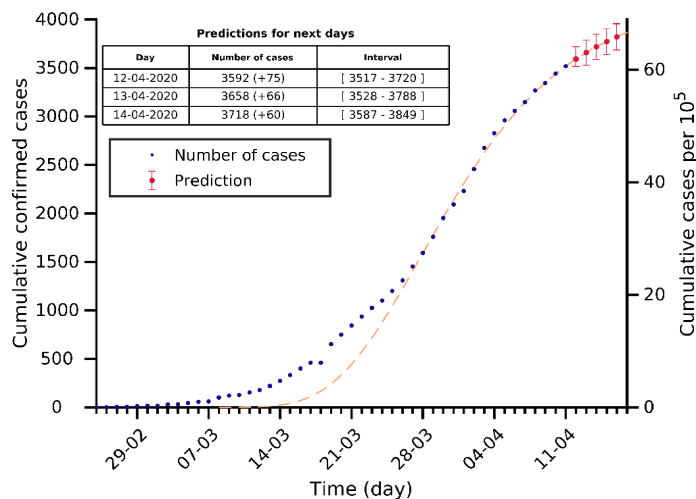
Marche
 11-04-2020.
 Population: 1.5M.
 Current cumulated incidence: 342/10⁵



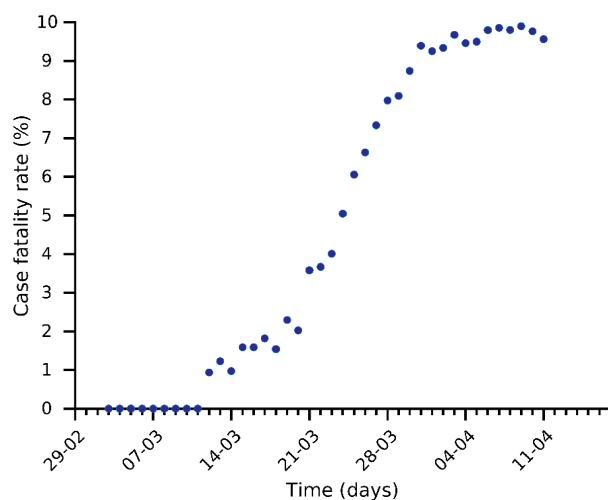
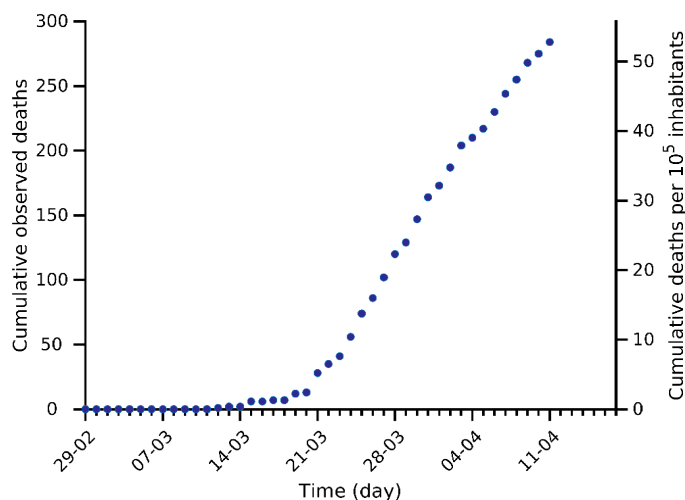
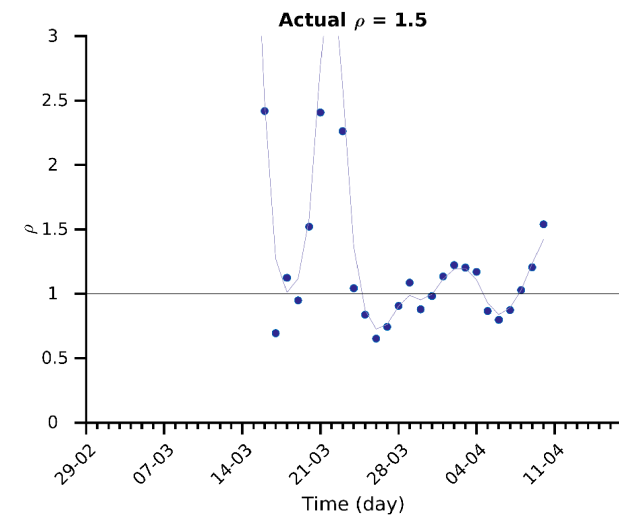
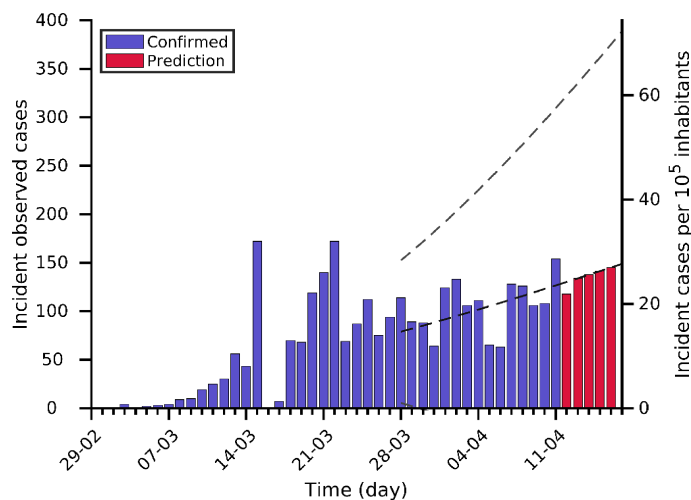
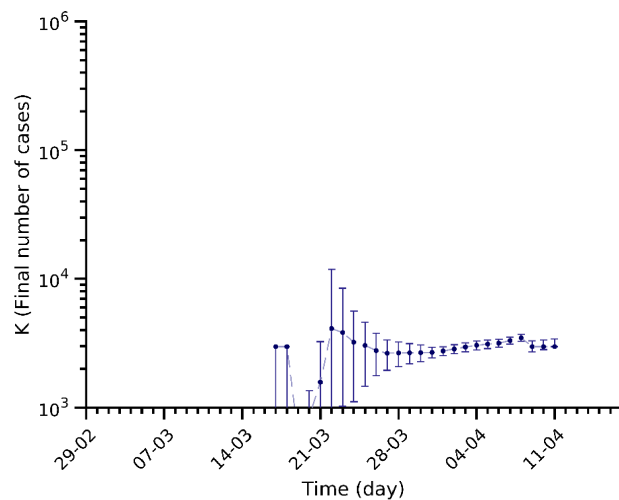
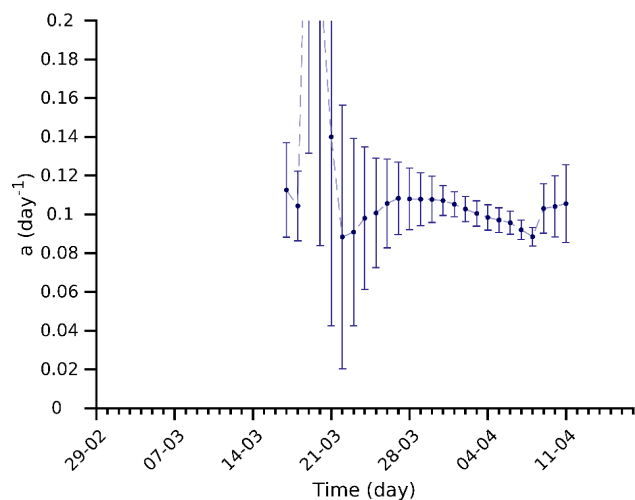
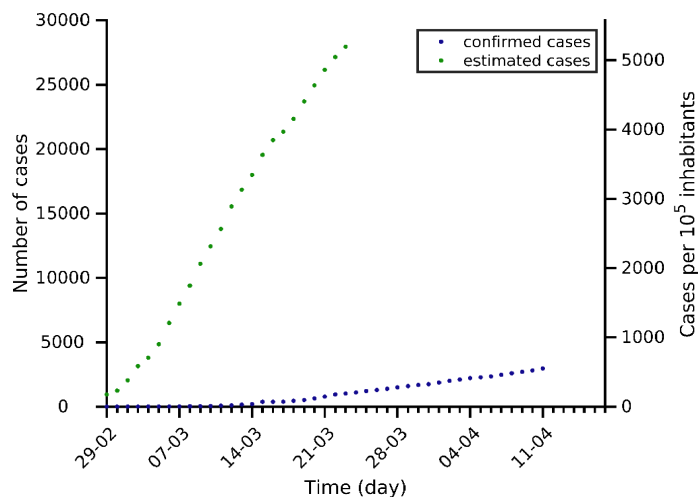
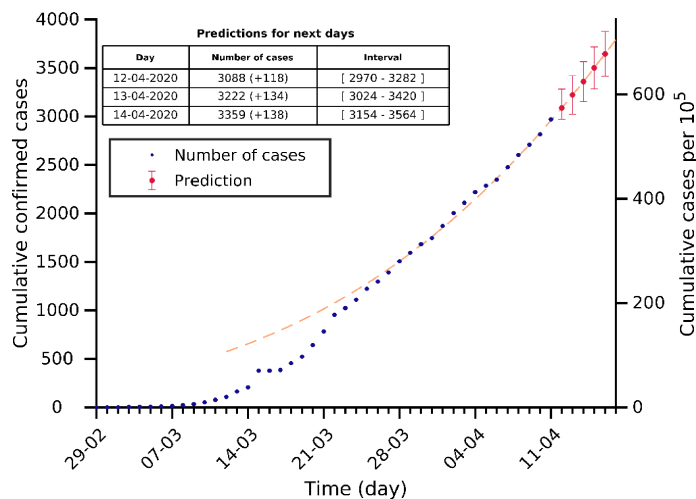
Lazio 11-04-2020. Population: 5.9M. Current cumulated incidence: 80/10⁵



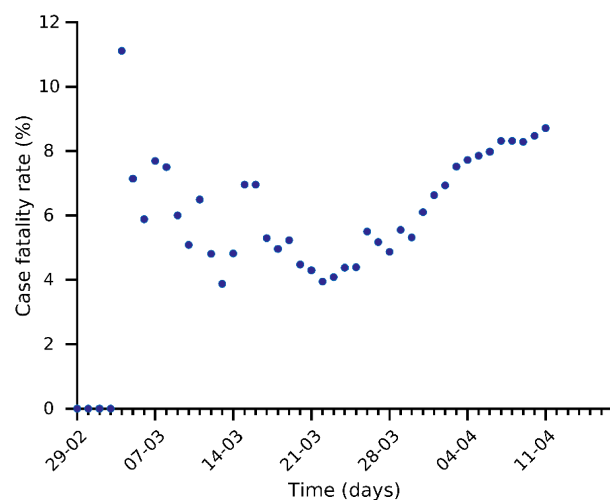
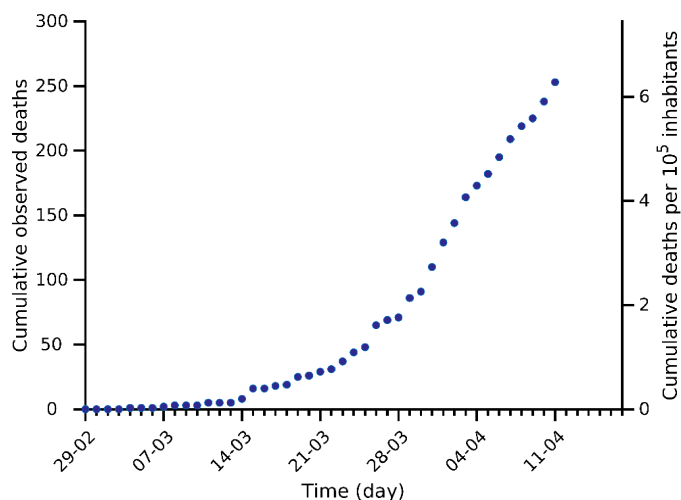
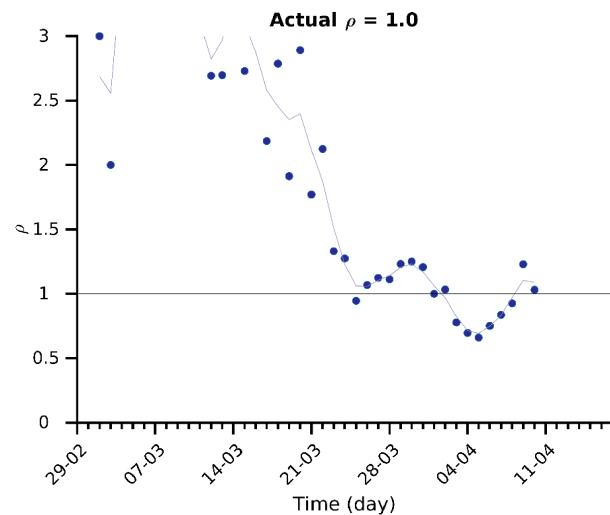
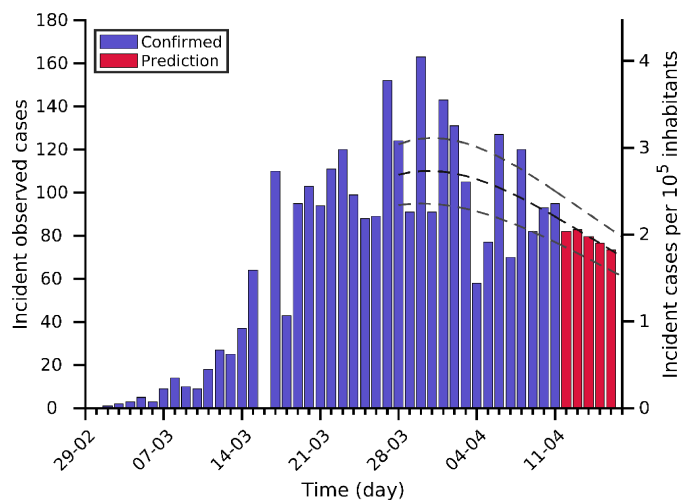
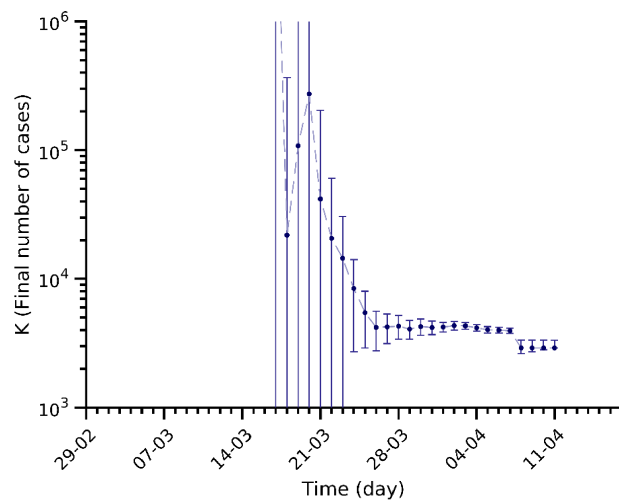
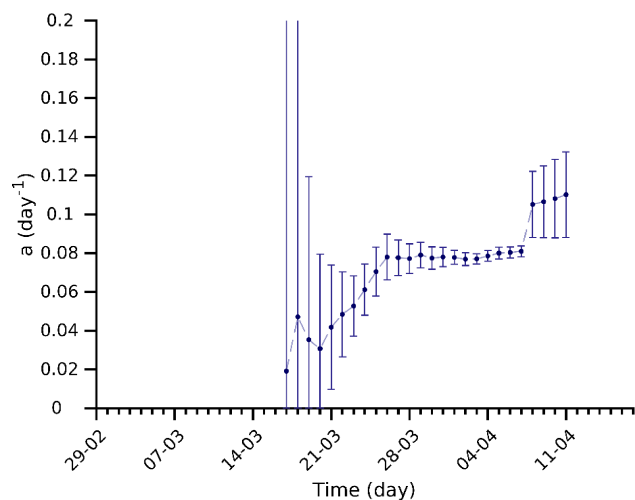
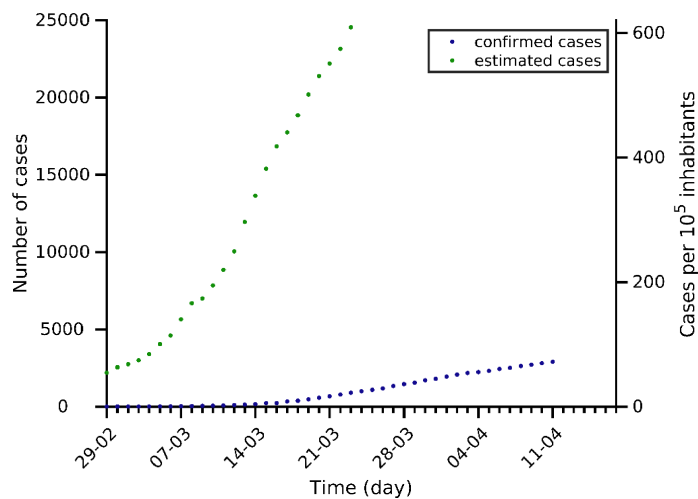
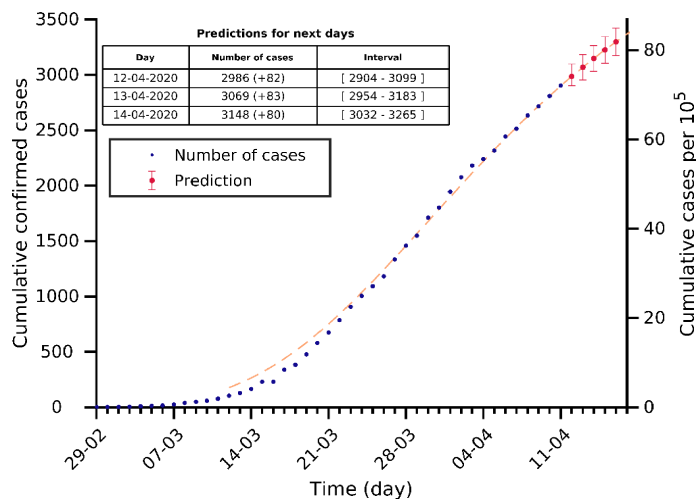
Campania 11-04-2020. Population: 5.8M. Current cumulated incidence: 61/10⁵



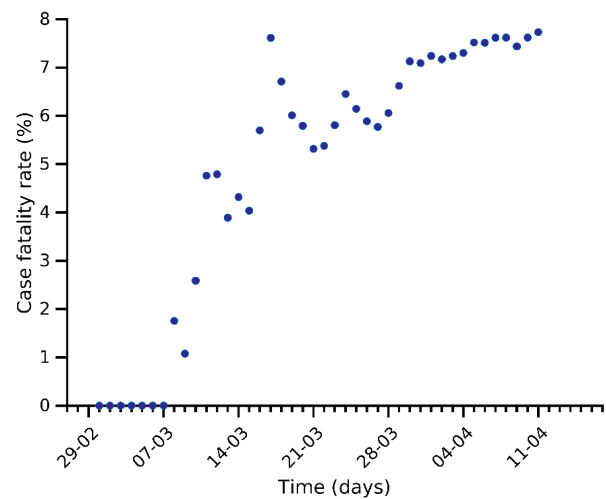
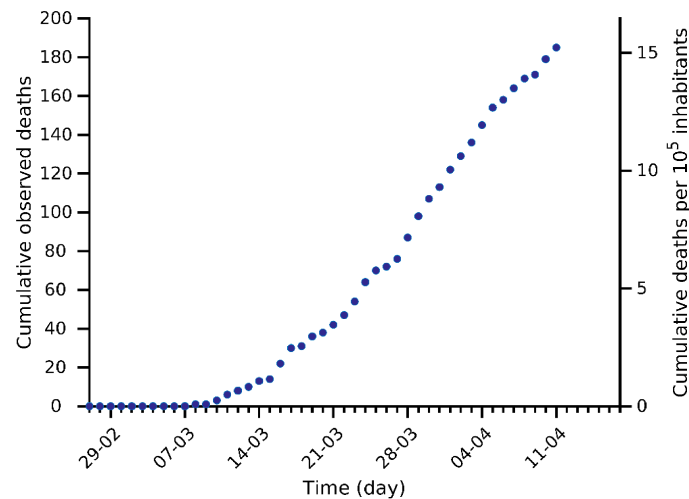
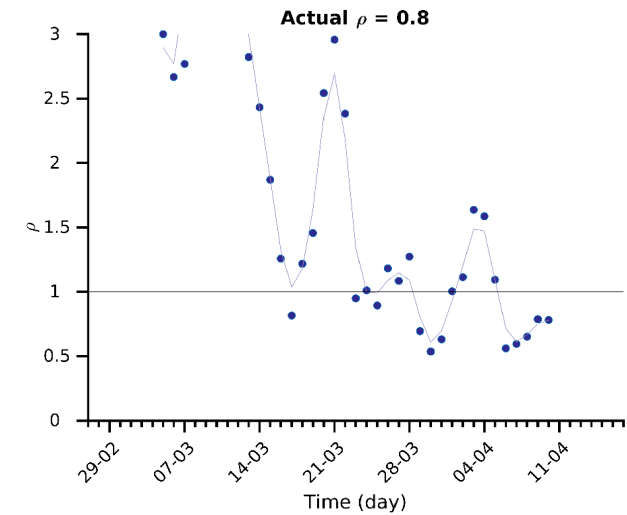
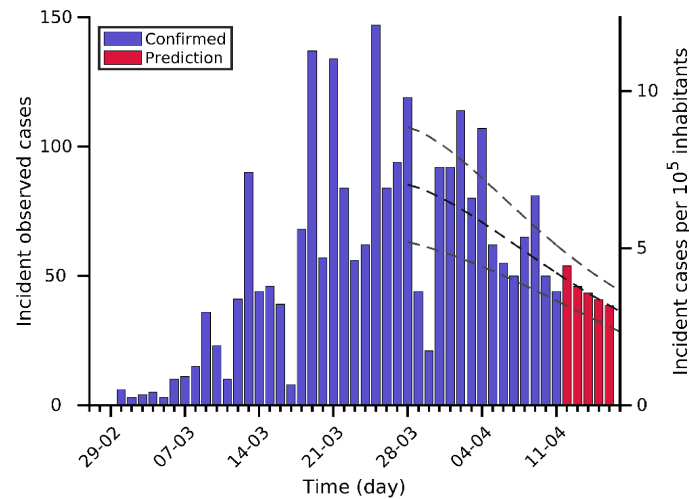
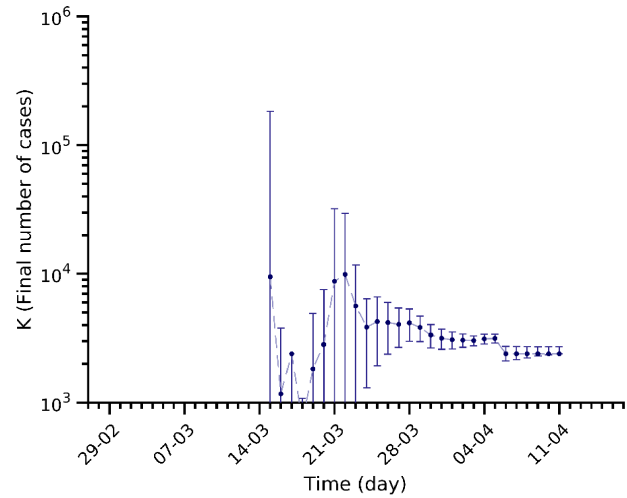
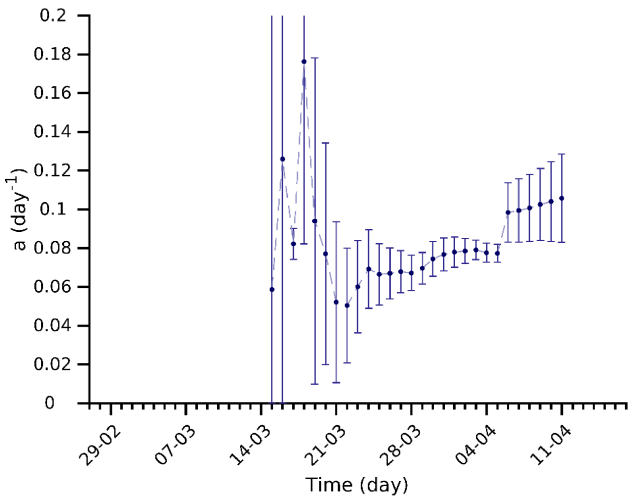
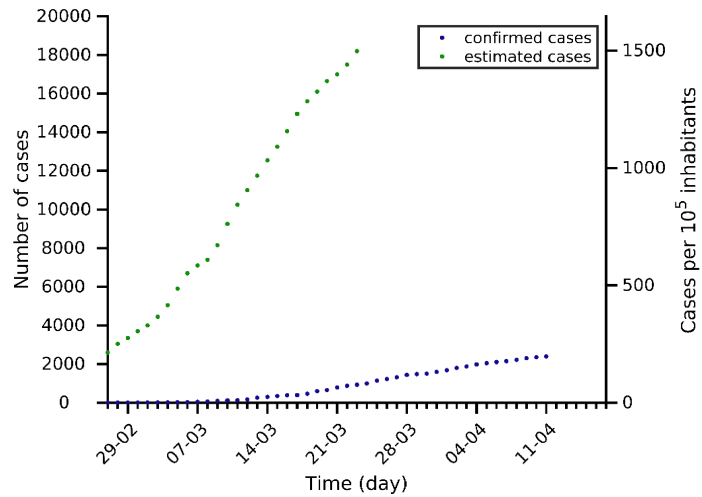
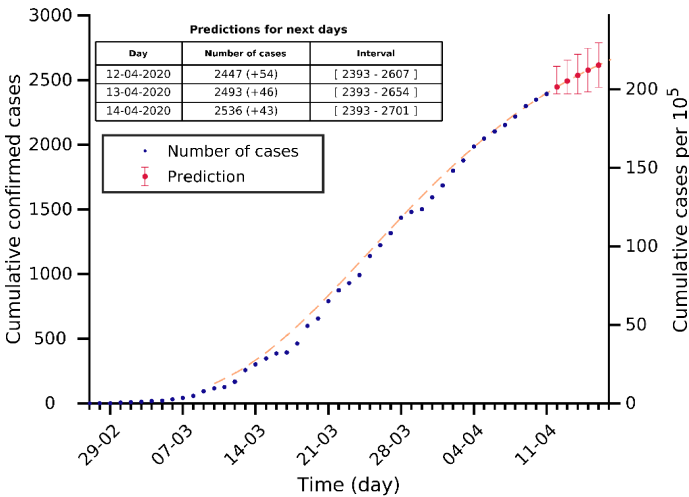
Trento 11-04-2020. Population: 0.5M. Current cumulated incidence: 552/10⁵



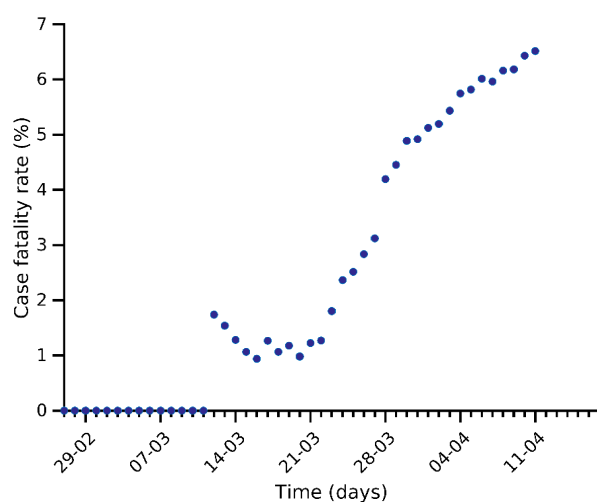
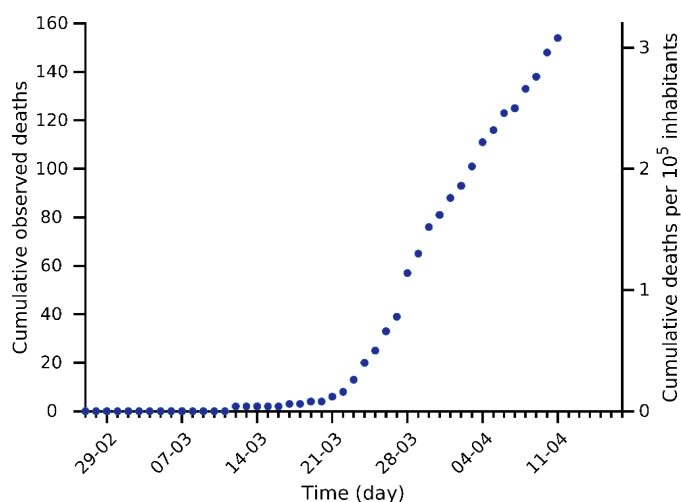
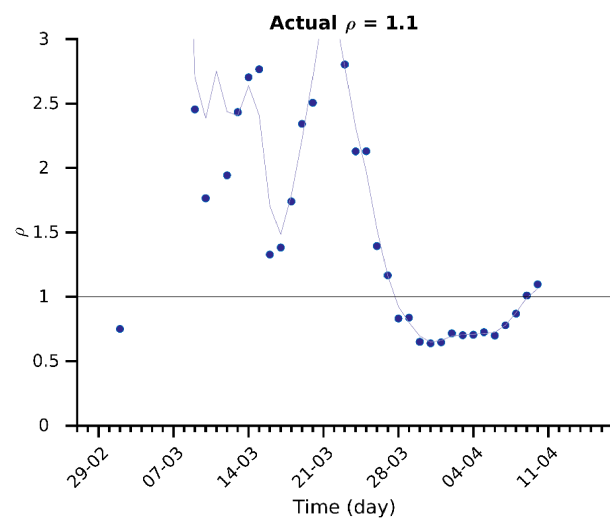
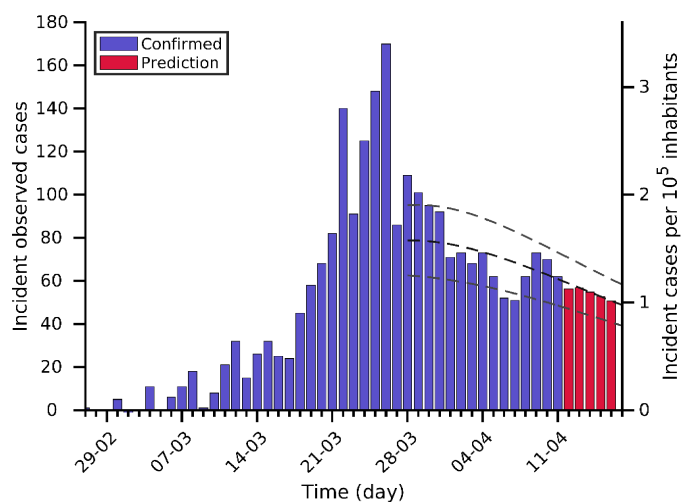
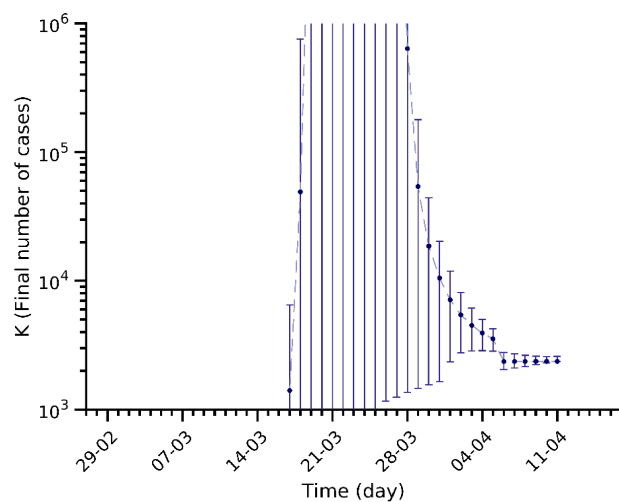
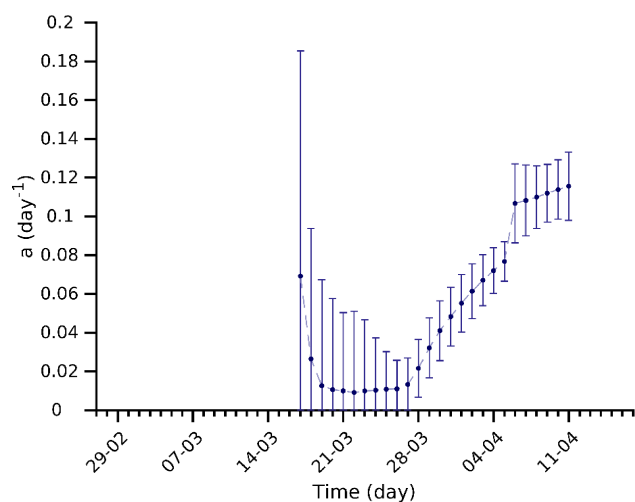
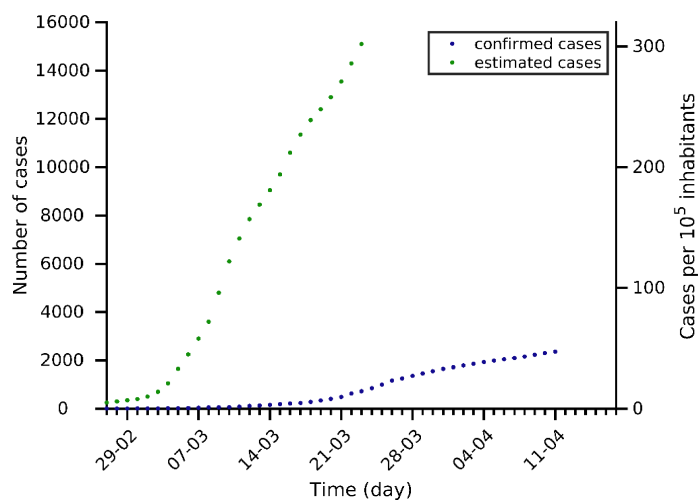
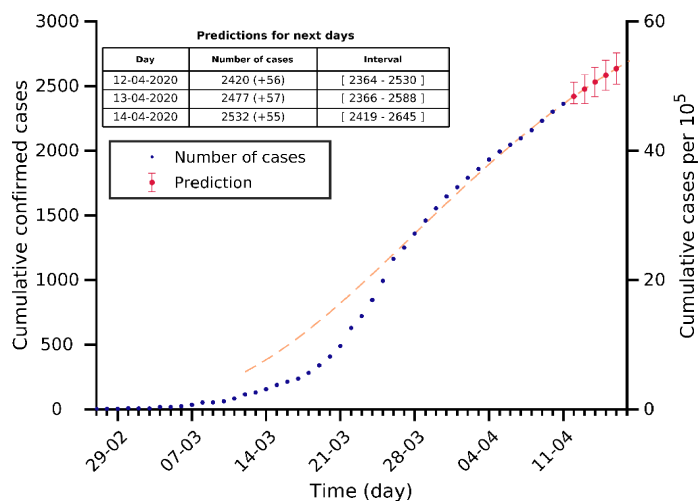
Puglia 11-04-2020. Population: 4.0M. Current cumulated incidence: 72/10⁵



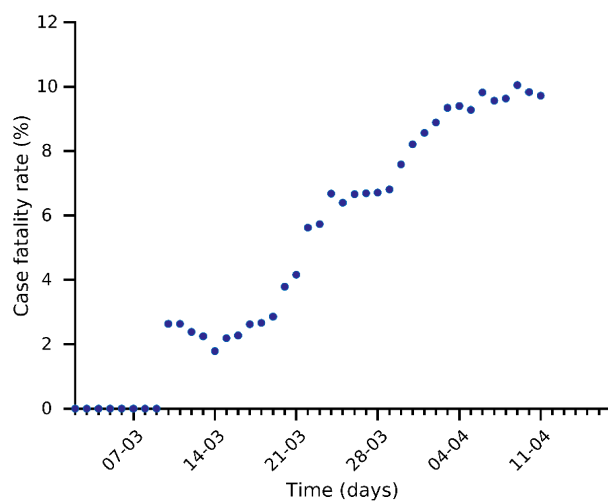
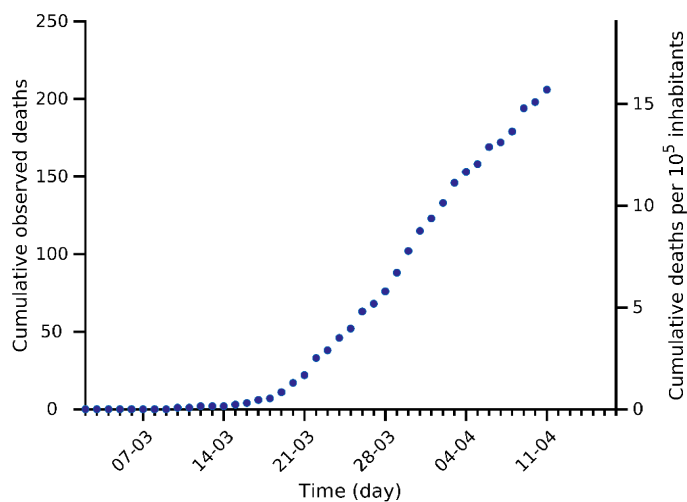
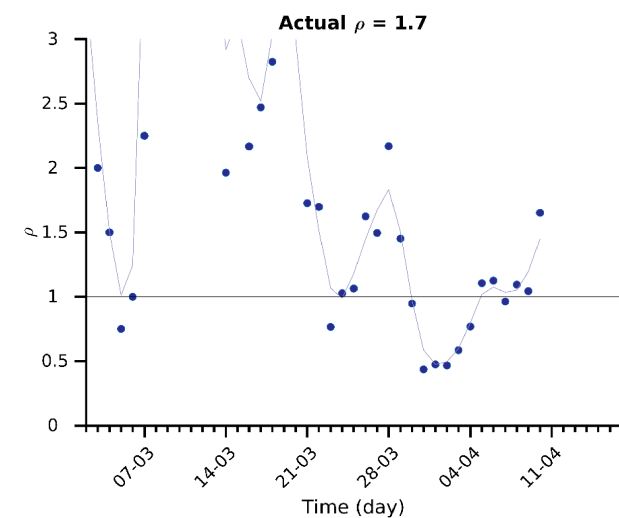
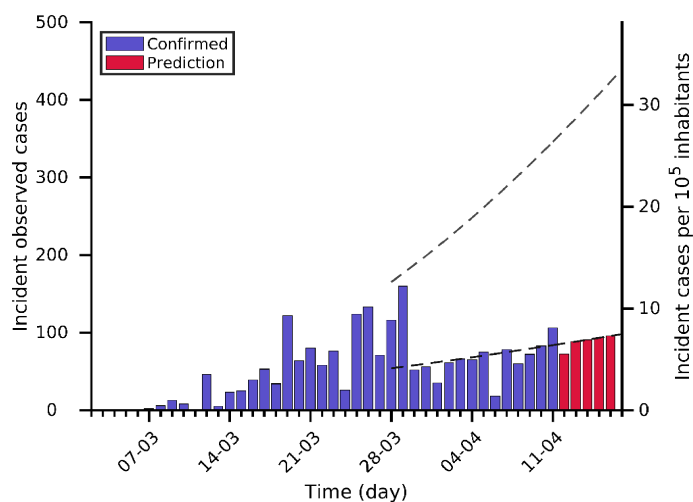
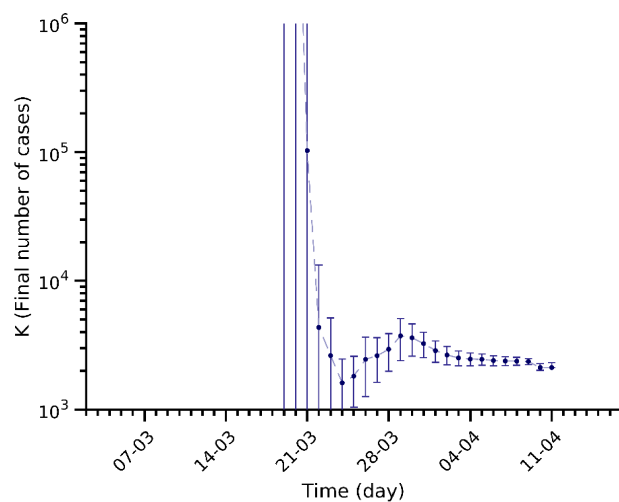
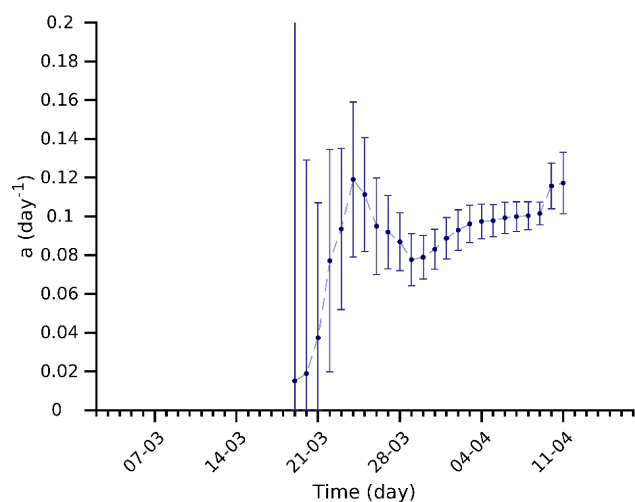
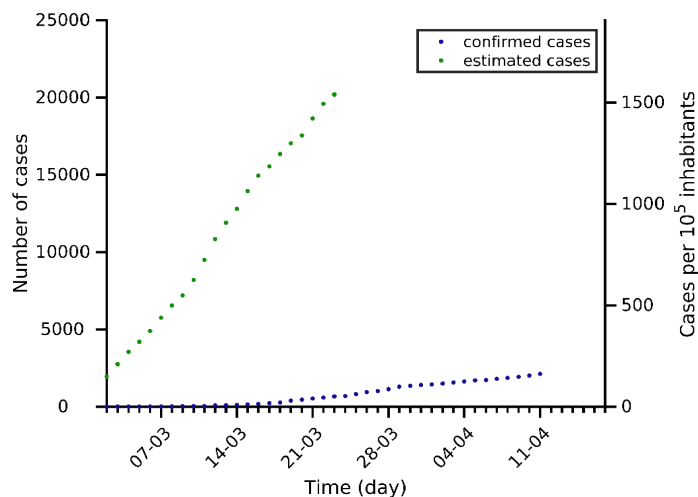
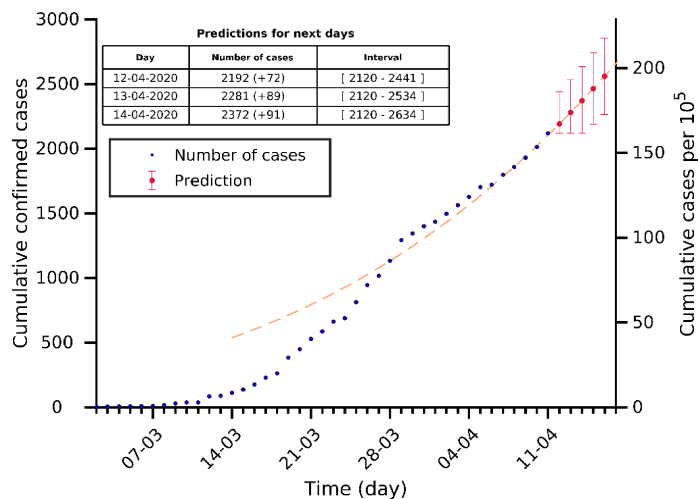
Friuli Venezia Giulia 11-04-2020. Population: 1.2M. Current cumulated incidence: 1



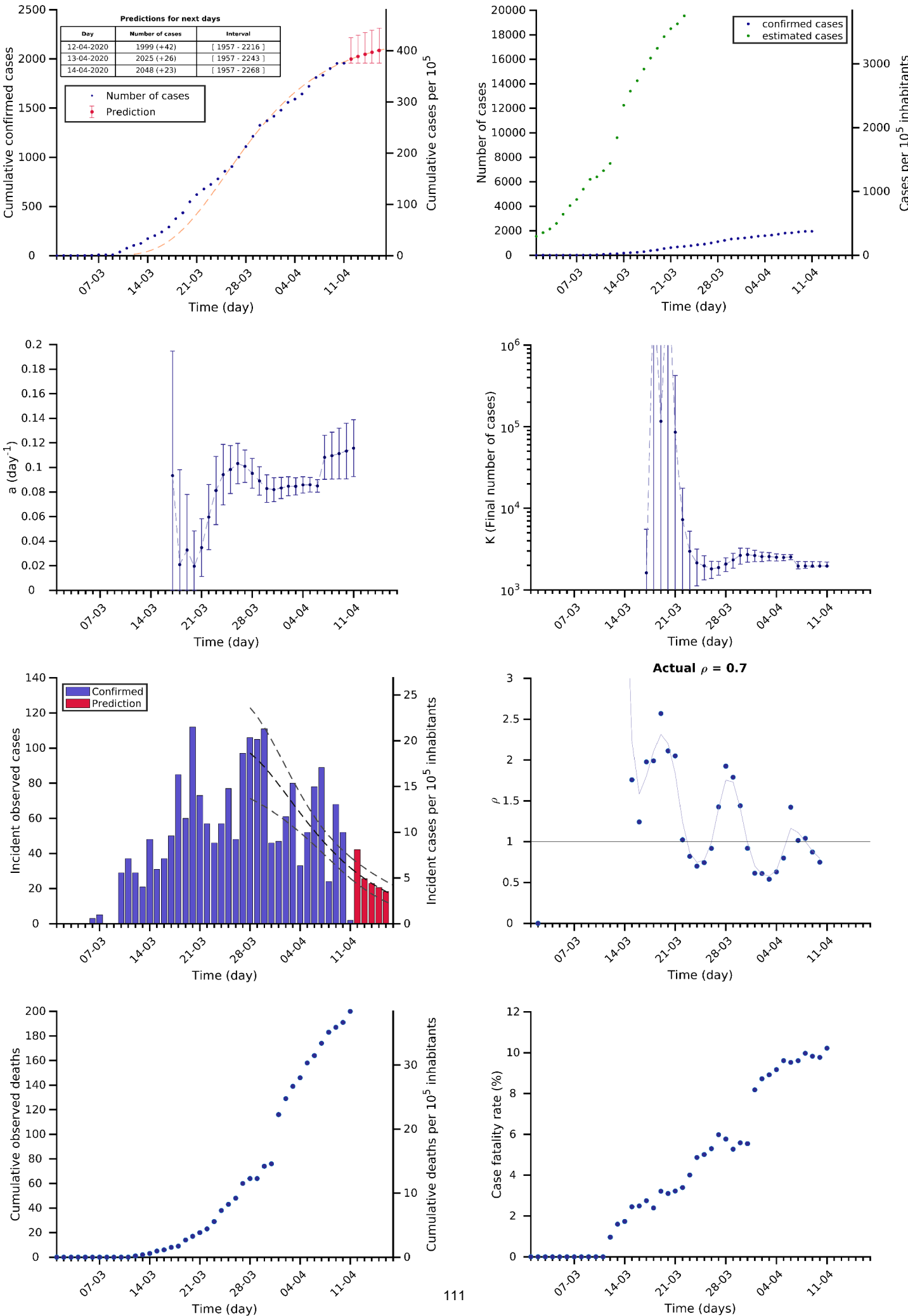
Sicilia 11-04-2020. Population: 5.0M. Current cumulated incidence: 47/10⁵



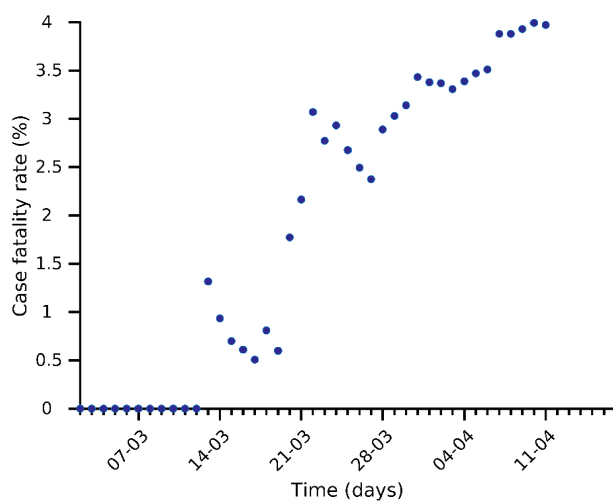
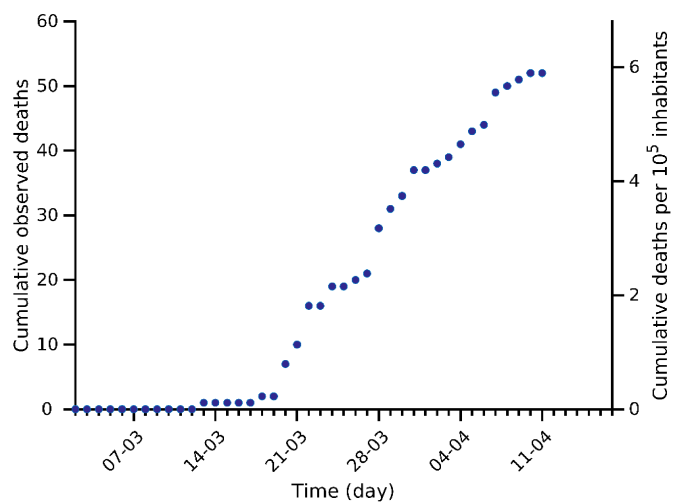
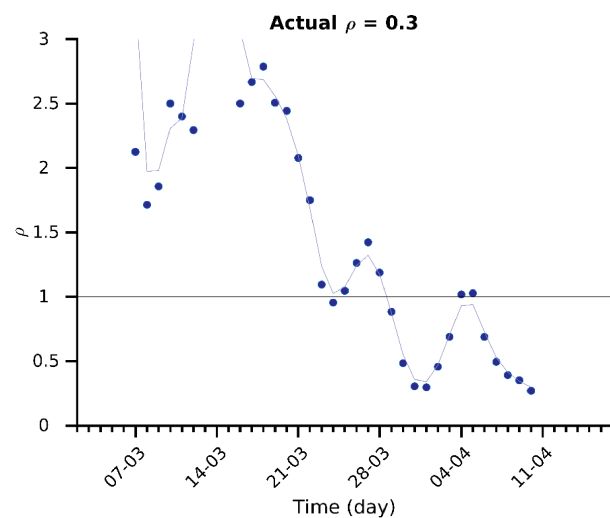
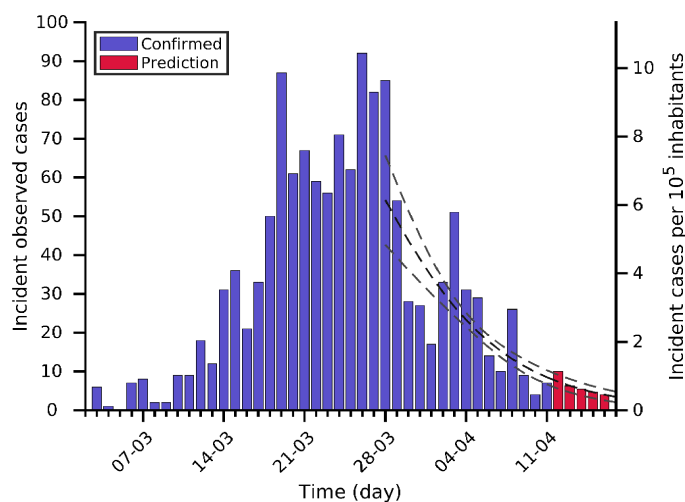
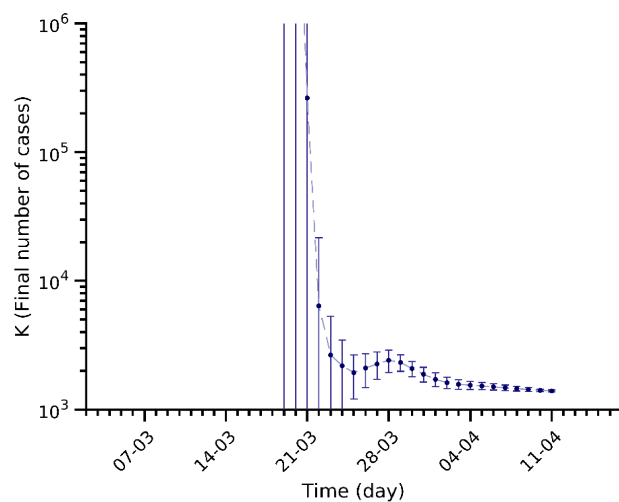
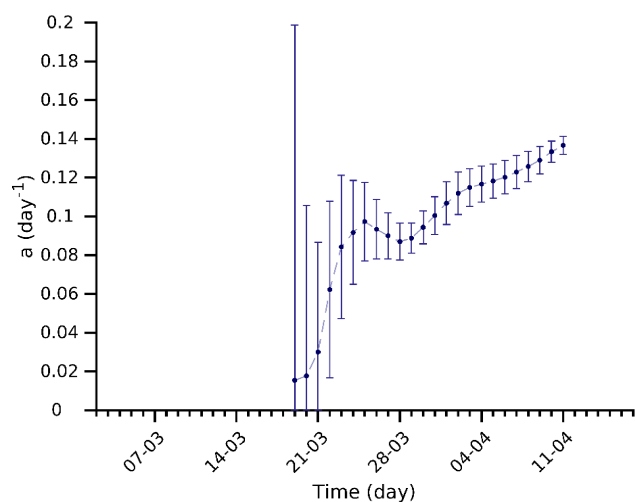
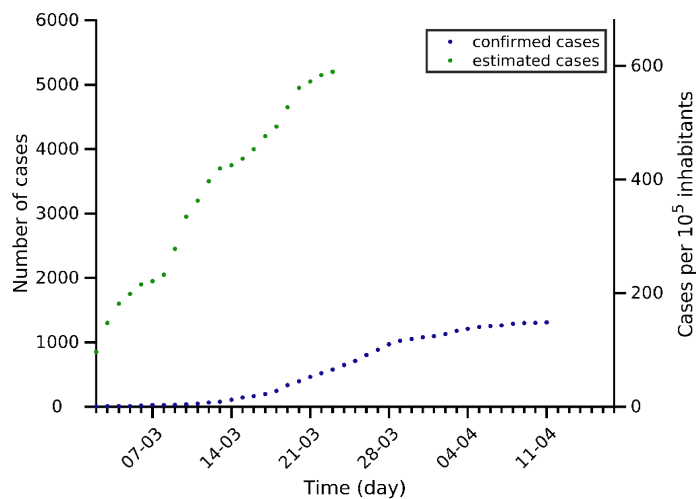
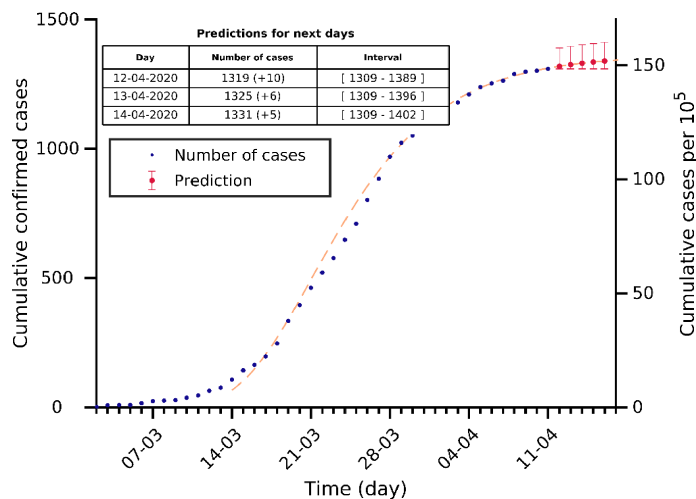
Abruzzo 11-04-2020. Population: 1.3M. Current cumulated incidence: 162/10⁵



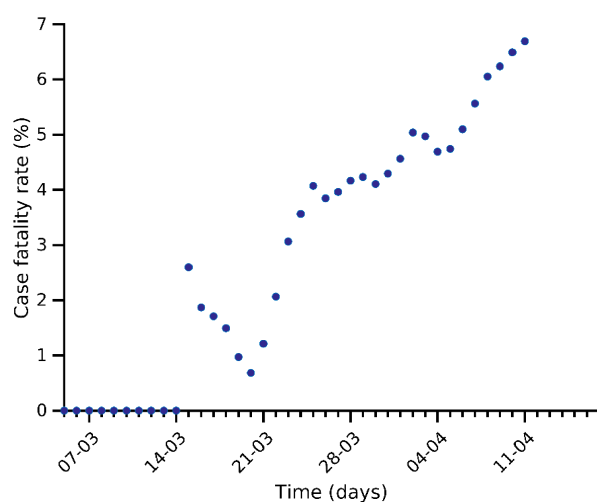
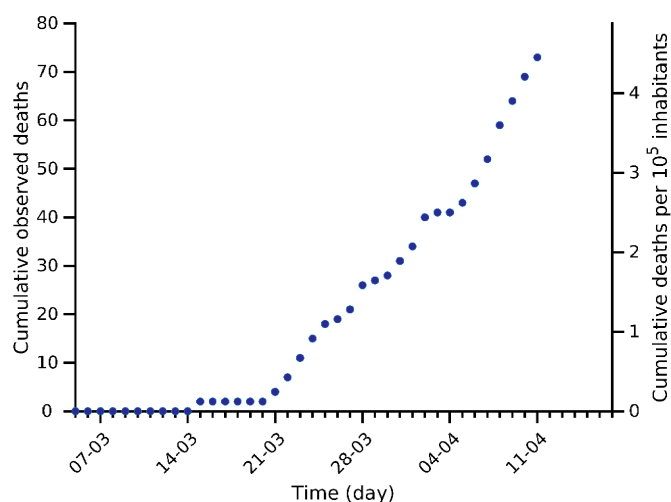
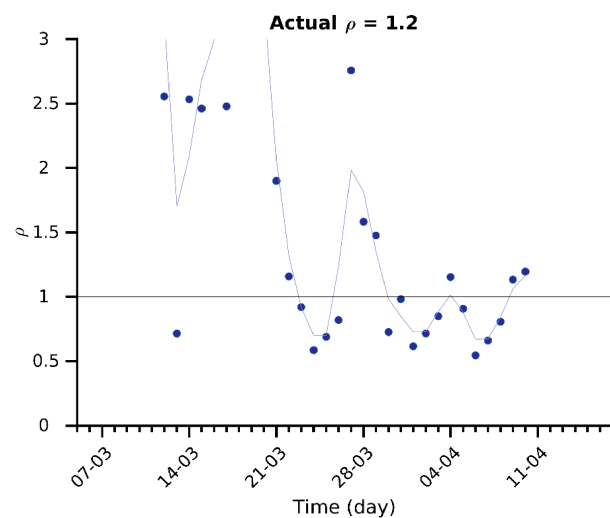
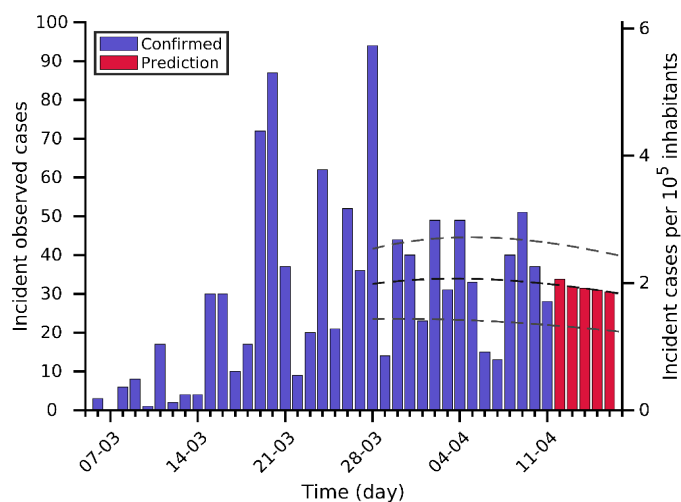
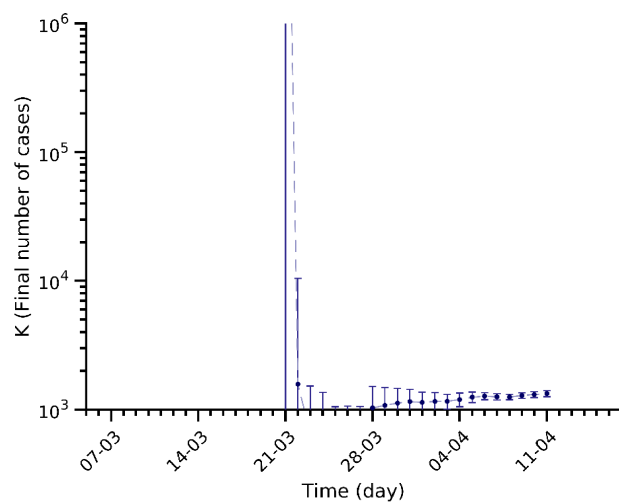
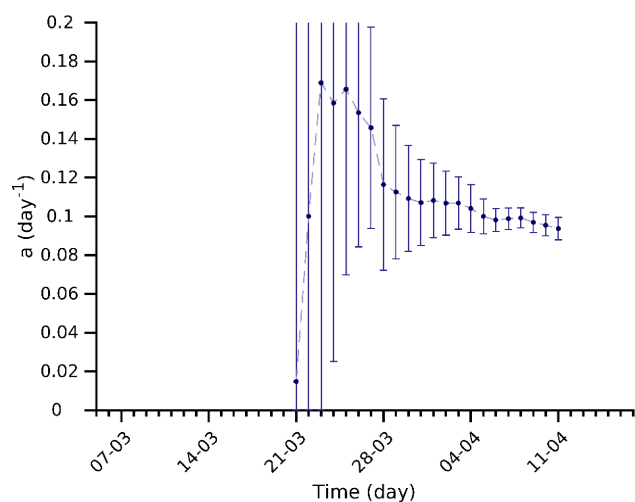
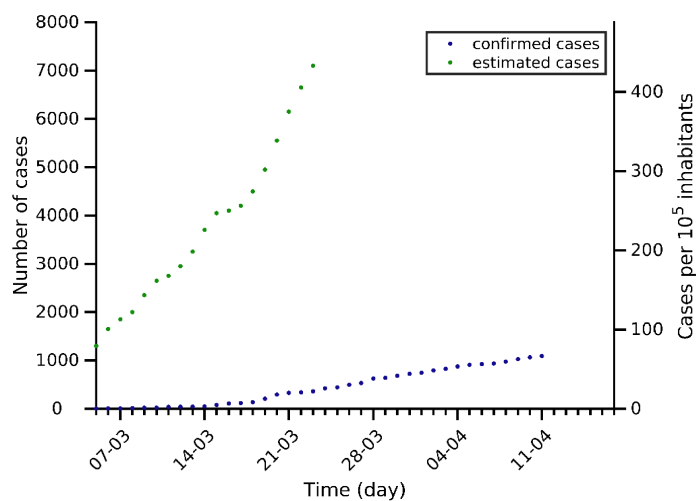
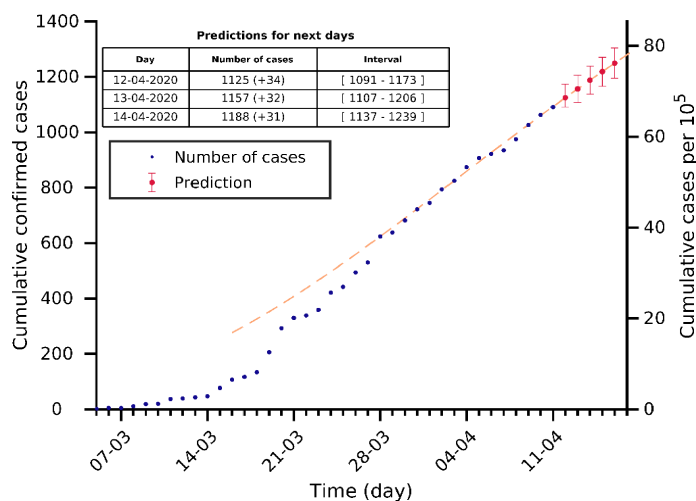
Bolzano 11-04-2020. Population: 0.5M. Current cumulated incidence: 376/10⁵



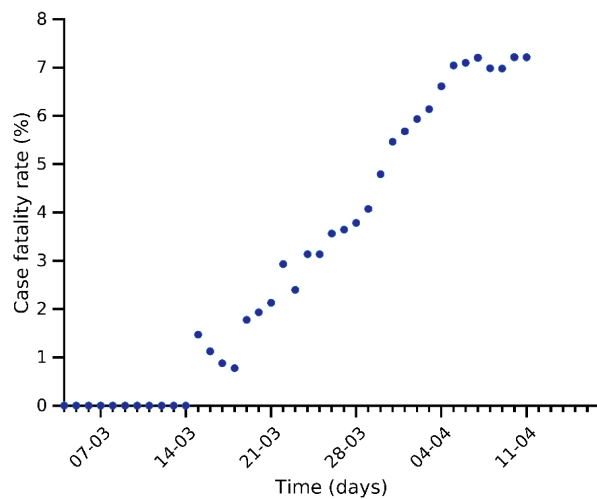
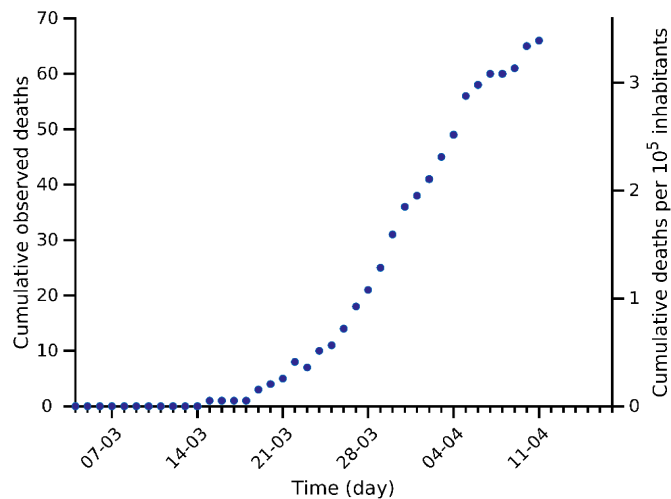
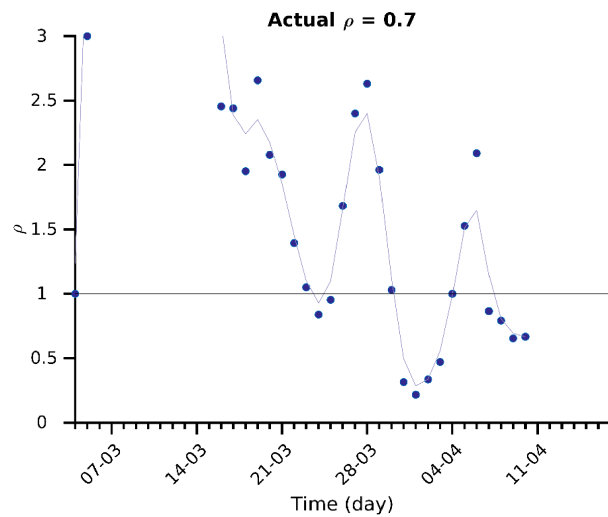
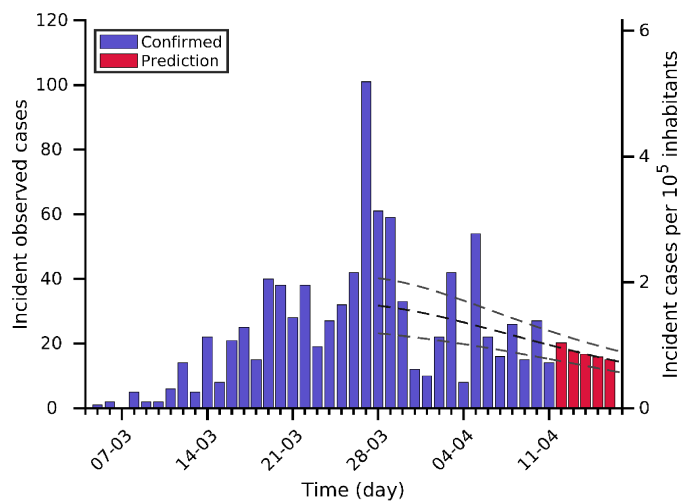
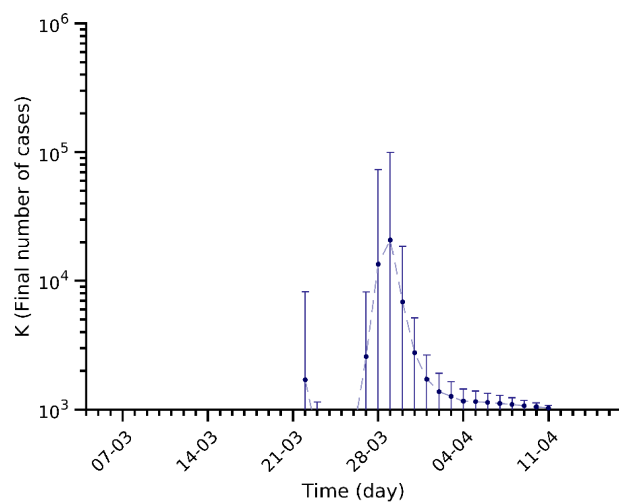
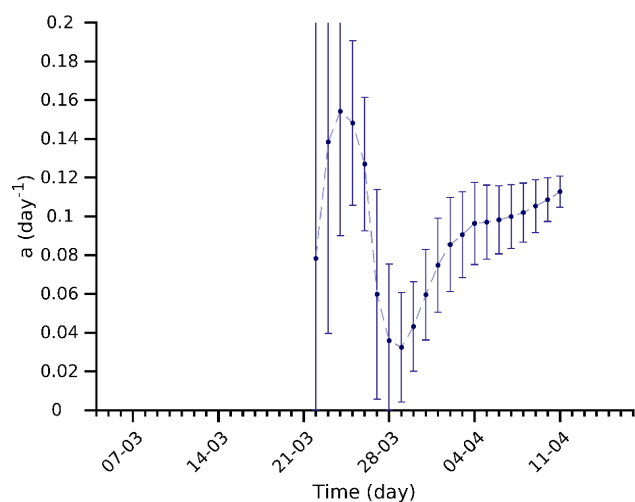
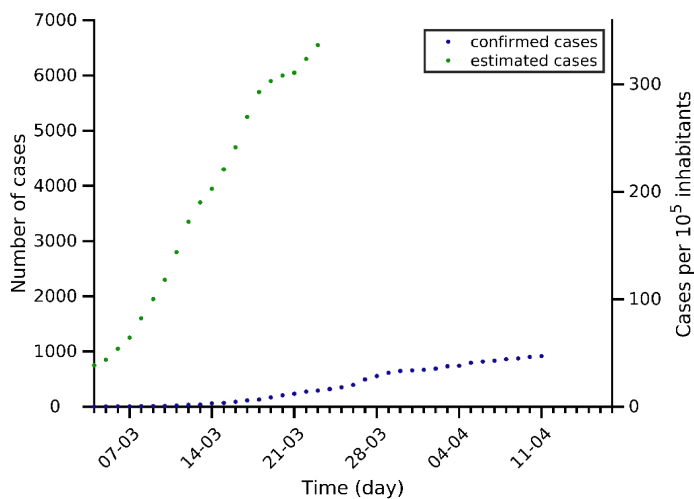
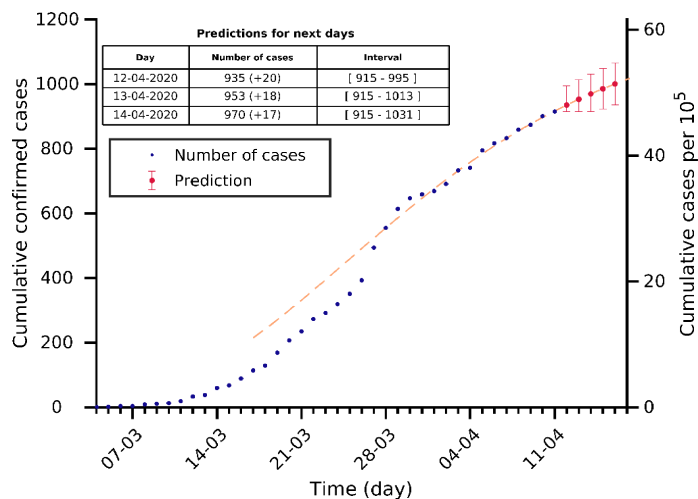
Umbria 11-04-2020. Population: 0.9M. Current cumulated incidence: 148/10⁵



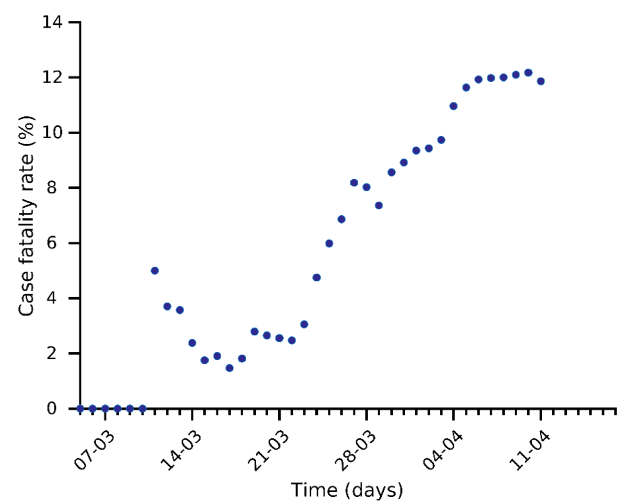
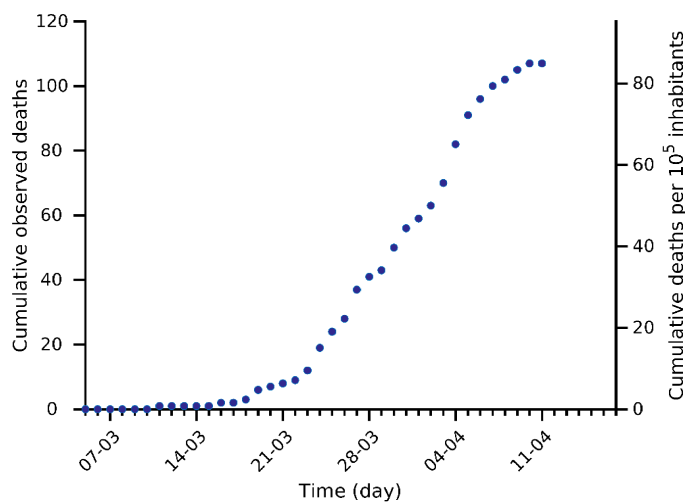
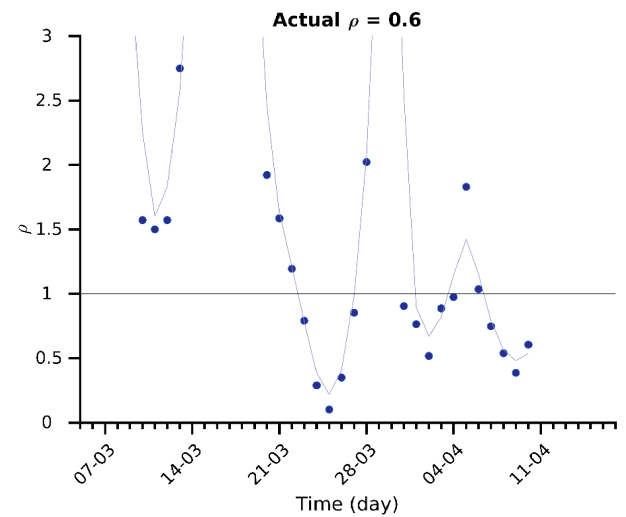
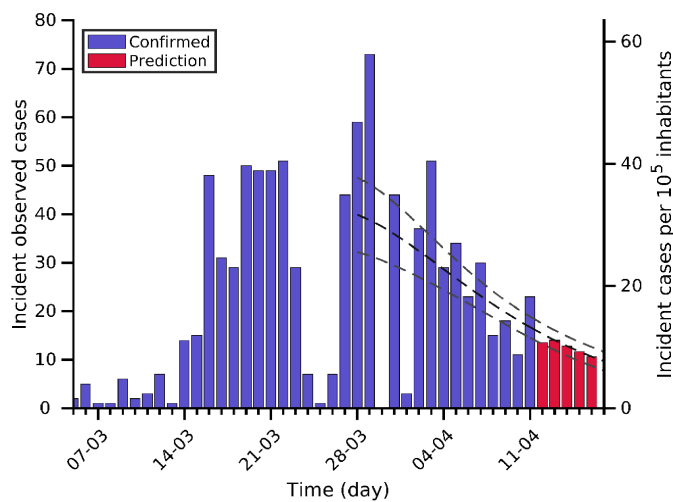
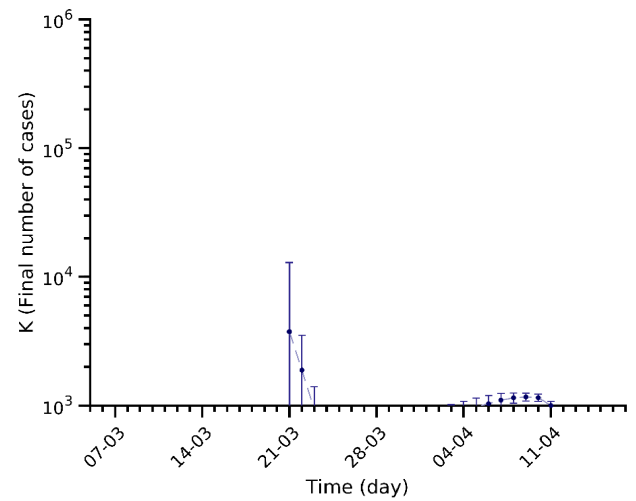
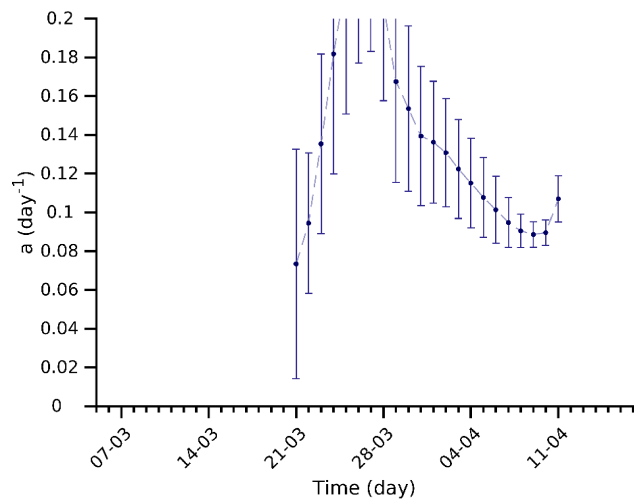
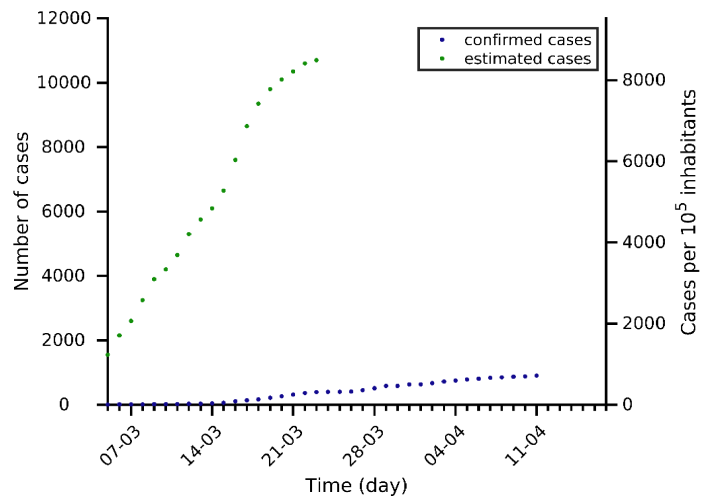
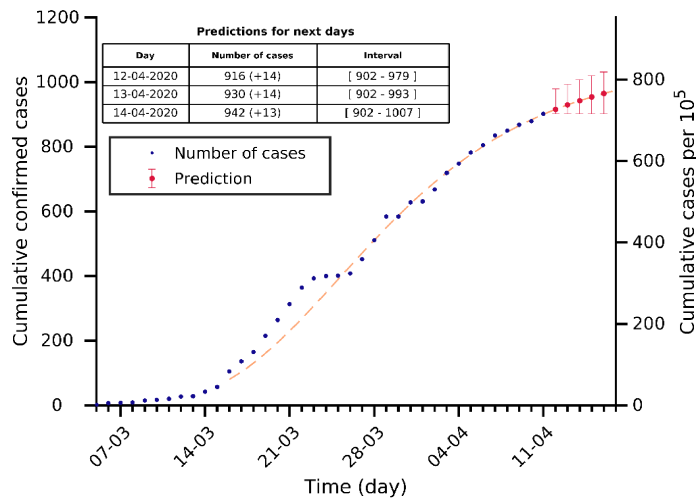
Sardegna 11-04-2020. Population: 1.6M. Current cumulated incidence: 67/10⁵



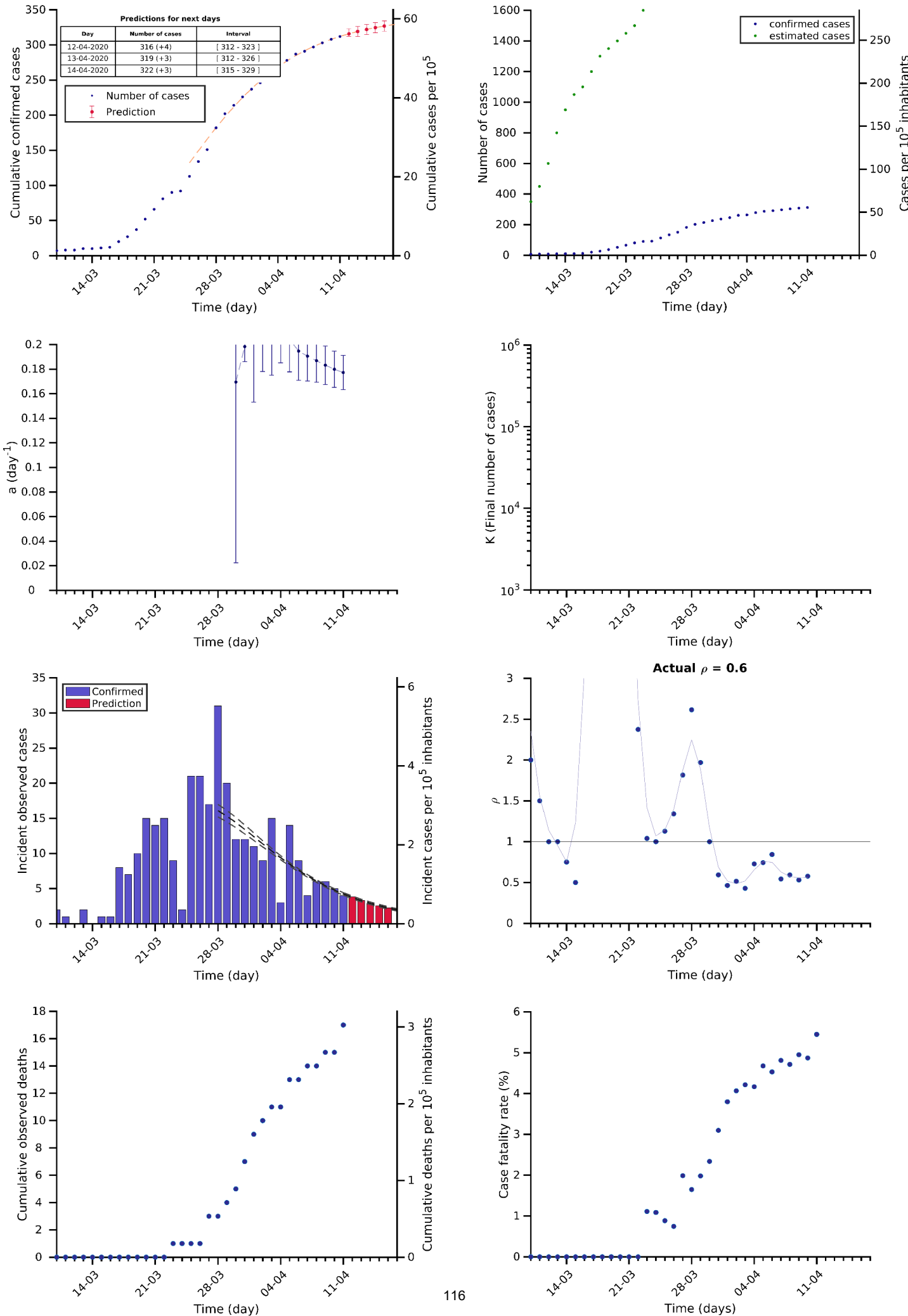
Calabria 11-04-2020. Population: 1.9M. Current cumulated incidence: 47/10⁵



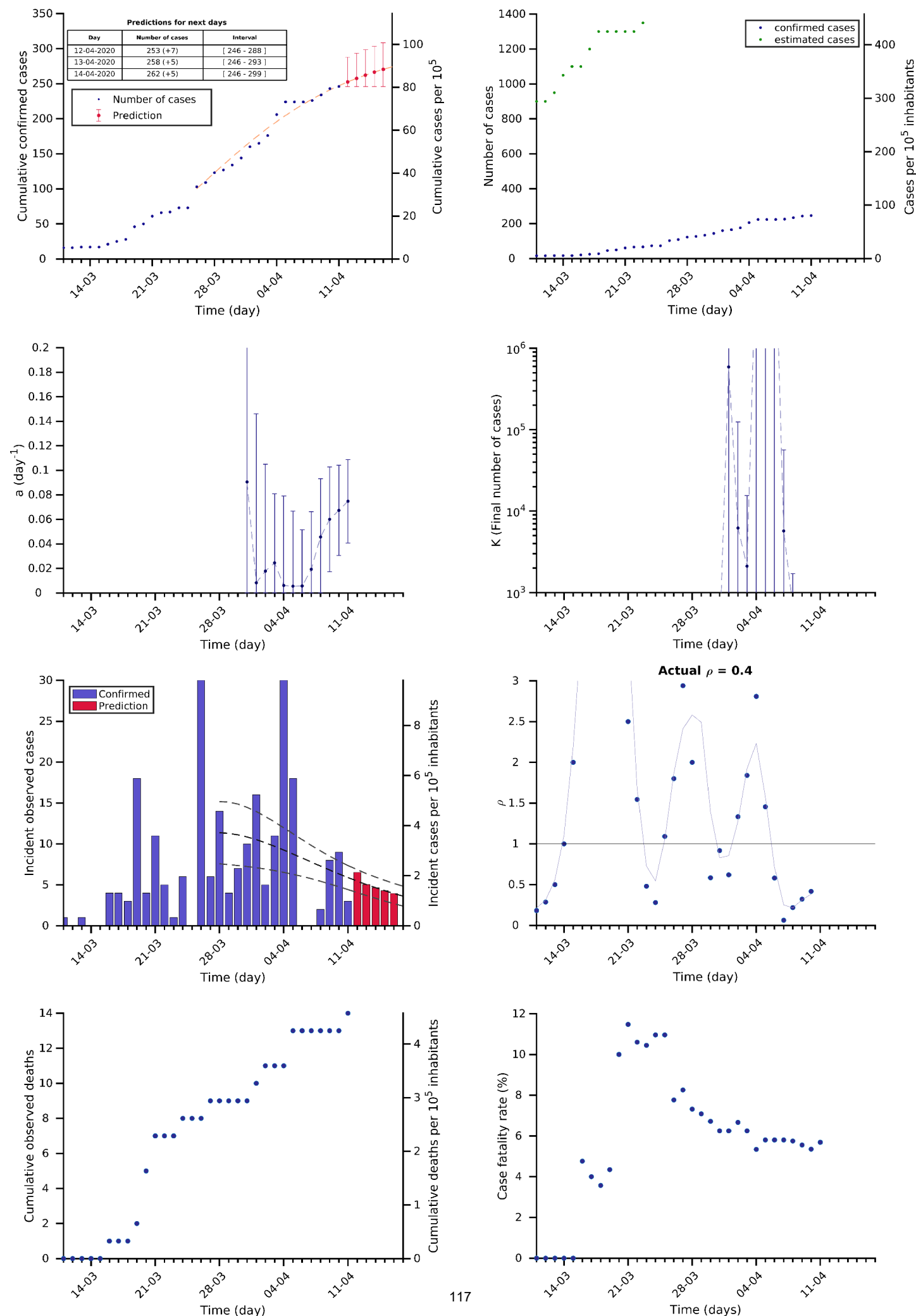
Valle d'Aosta 11-04-2020. Population: 0.1M. Current cumulated incidence: 716/10⁵



Basilicata 11-04-2020. Population: 0.6M. Current cumulated incidence: 56/10⁵



Molise 11-04-2020. Population: 0.3M. Current cumulated incidence: 80/10⁵



Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports¹, from European Centre for Disease Prevention and Control (ECDC)² and from Ministerio de Sanidad³. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t .

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

¹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

² <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

³ <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>
<https://github.com/datadista/datasets/tree/master/COVID%2019>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model⁴ correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ a is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (a and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is a . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted a with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted K with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $a > 0.2 \text{ day}^{-1}$, if $K > 10^6$ or if the error in K overpasses 10^6 .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

⁴ Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days⁵;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors⁶ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

⁵ At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

⁶ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3